CIVIL ENGINEERING

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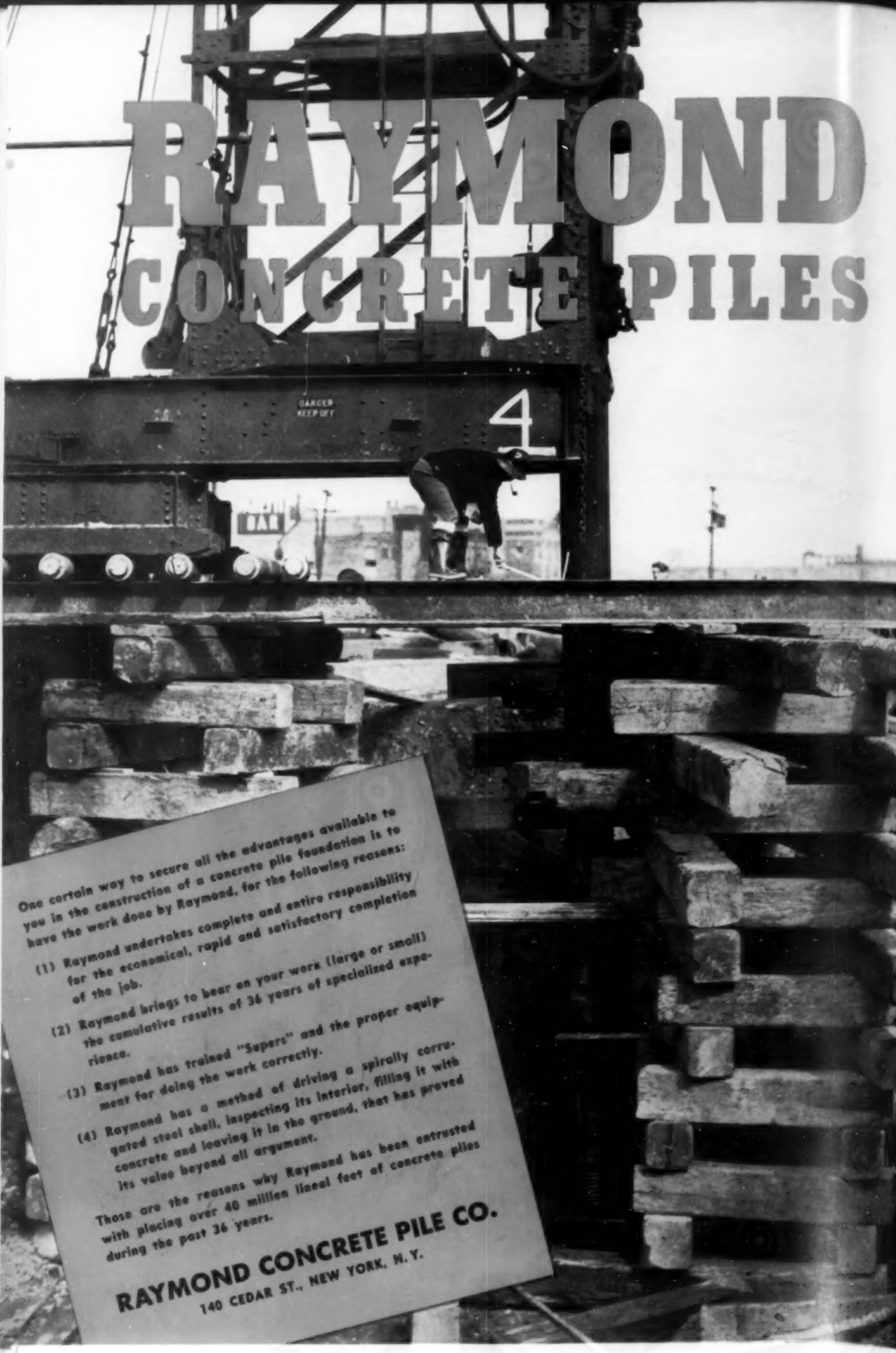
Sardis Dam, Mississippi, as of April 20, 1939; Work in Progress on Outlet (Foreground, Left of Main Dam), One Section of Hydraulic Fill, and Spillway (Background). Future Reservoir Area Is on Right

Volume 9 — AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852 — Number 6

JUNE 1939



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Among Our Writers

J. K. Finch, who has been teaching civil engineering for over 25 years, is now head of the civil engineering department at Columbia University. He has long been interested in the broader problems of engineering education, and particularly in the development and teaching of engineering economics. He completed a term as Director of the Society in January 1939.

E. De V. Tompkins (School of Mines, Columbia University, 1896) has had wide experience as engineer on the design of bridges, buildings, and waterfront structures, and for 15 years as a contractor for construction of such structures. For the past 25 years he specialized in valuation work, expert testimony in engineering litigation, and condemnation proceedings.

Ralph W. Stewart received his bridge engineering instruction at the University of Wisconsin under the then young professor Frederick E. Turneaure. After graduation he spent several years in railway engineering and has since been on the staff of the City Engineer, Los Angeles—most of this time in his present position in charge of the division of bridge and structural design.

D. S. Laidlaw (University of Toronto, 1928) became a member of an architectural firm after several years on construction and in mortgage work. He is now in private practice. In 1933, he was made chairman of the Editorial Subcommittee of a Joint Committee of Engineers, Architects, Business Men, and Building Officials that has, since then, been slowly revising the building by-laws of his native city.

M. P. Anderson has a long record of construction experience on dams, hydroelectric plants, and steam plants—particularly in connection with construction plant layout and design. Such were his duties at both Norris and Grand Coulee, the two projects immediately preceding his present work at Marshall Ford.

L. E. Grinter (U. of Kansas, 1923; U. of Illinois, 1926) spent three years as a designer with the Standard Oil Co. of Indiana, and 8 years as a professor at Texas Agricultural and Mechanical College, before going to his present post in 1937. His publications include 25 or more monographs, and 2 books on the theory of steel structures.

Norman R. Moore (Minnesota, 1925), following several years of railroad and highway work, was associated with the Dayton Morgan Engineering Co. on design of flood control works for the Springfield (Ohio) Conservancy District, and with the Zanesville Engineer Office on design and construction of dams for the Muskingum project. He has had charge of the design of major flood control works in the Vicksburg Engineer Office since 1936.

Harley B. Ferguson has served with the Corps of Engineers since his graduation from West Point in 1897. He became president of the Mississippi River Commission in 1932. Previous articles by General Ferguson, describing in detail a part of the work to which he alludes briefly in his present paper, were published in Civil Engineering in November and December 1938.

Theodore B. Parker is a graduate of Massachusetts Institute of Technology and the U. S. Army Engineer School. He was employed for 18 years as a hydraulic engineer, first by Electric Bond and Share Company, and later by Stone and Webster. During the War he served in France with the 26th Engineers. Since 1933 he has been in government employ; appointment to his present post was in 1937.

A. H. Holt graduated in engineering from the University of Vermont, and in law from the State University of Iowa, and taught civil engineering at both universities before going to his present post. His experience also includes design and construction, and work on many surveys in both an engineering and a legal capacity. He is a member of the state bars of Iowa and Massachusetts.

F. E. Junior (Northeastern University, 1922) engaged in railroad and land subdivision development in Massachusetts and Florida until 1927. He was then employed as chief design engineer with the City of Pontiac, Mich., during an expansion program; and was later a designer with the Missouri State Highway Department. He has been with the TVA since 1933.

Volume 9 Number 6

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Something to Think About

A Series of Reflective Comments Sponsored by the Committee on Publications

Practicing Engineers as Educators

By J. K. Finch, M. Am. Soc. C.E.

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The engineering profession has long been active in the critical study and appraisal of its agencies for formal engineering training—the engineering schools. In fact, in the United States, our schools have been under practically continuous examination, criticism, and even pressure for almost a quarter century—from Dr. Mann to the present accrediting program.

Postgraduate Training.~Apparently, in this rush to investigate, to improve, and to reform education, we have lost sight of the fact that the formal training offered by our schools is but part of the educational process. Engineers have long insisted that the schools can teach only theory and fundamentals, and that the young graduate, must, through a period of apprenticeship in actual engineering work, learn to temper theory with practice, and through contact with and experience in actual work, develop a true professional ability. The postgraduate training of the young engineer through apprenticeship is thus not only traditional in our profession but is still regarded as a vital element in engineering education. Witness, for example, the fact that four years of special experience following graduation are essential before a candidate can even apply for a license to practice engineering. The young engineer is sometimes said to have "finished his education" when he graduates, but this is clearly an erroneous idea.

Furthermore, no mere routine technical employment will satisfy this requirement for postgraduate training. The conditions of employment of the young engineering graduate, the opportunities offered for him to develop professional qualities—in short, the effectiveness and ability of the employer-engineer as an administrator of engineering education and a postgraduate teacher, are thus of equal importance with the work of our schools in judging the effectiveness of engineering education. Whether he likes it or not, the practicing engineer with young men working under him must be considered just as much a professor of engineering as the teacher in an engineering school.

There thus seems to be no reason why investigations of engineering education should not include a thorough and critical study of the work of the practicing engineer as an engineering educator and the facilities offered by the engineer-employer for postgraduate training. "Turn about is fair play," and it should be permissible for an engineering educator to review the educational activities of the professional engineer and, perhaps, to suggest that some rather basic changes and improvements are in order.

Need for Cooperation.~And so, since the engineering teacher and the practicing engineer are both engineering educators, it is clear that they should work hand in hand in selecting the best material for training and in supporting each other regarding standards. For example, one of the first educational responsibilities of the practicing engineer is to see that, in employing a young man, or in other words selecting a candidate for postgraduate training in his office, he gives due weight to the character and scope of the applicant's earlier training.

In too many cases, little or no attention is given to the degree an applicant for apprenticeship training may hold or to the reputation of the school from which he has graduated. In fact, it seems to be generally assumed that the mere statement that the applicant has graduated from some engineering course is all that is necessary in the way of educational qualification. In effect this assumes that all schools, good or bad, turn out a uniform product; it gives no weight whatever to graduate school work. Surely this is not a practice which can in any way contribute to raising the standards of engineering education, nor is it calculated to encourage the young man who seeks engineering apprenticeship to sacrifice the necessary time and effort required in securing the best preliminary training.

Distinction to Be Recognized.~Needless to say, personality and character—the man rather than his training—are and must remain important factors, perhaps the most important factors in the selection of personnel for any organization. But such lack of consideration for educational qualifications by the employer-engineer, this failure to examine educational credentials, encourages the schools to aim for the mass production of a mediocre product and discourages the advancement and progress of technical education of the better type.

While many "old line" engineers more or less distrust academic distinctions and look upon educational differences as of distinctly secondary importance, the continued progress of engineering education must, to a very

large extent, depend upon a more complete recognition by the practicing engineer of such variations and distinctions—of the possibilities and values of formal engineering education. If the professional engineer accepts his joint responsibilities with the engineering school, more than delegated authority or lip service is involved. He must, personally and individually, do his part in supporting the educational efforts of our progressive schools by giving due attention and weight to the educational background of applicants for employment in his office. Some government and industrial organizations are doing this—in a more or less effective manner—but many experienced engineers who direct engineering organizations or are engaged in private practice cannot be fully "accredited" in this phase of their activities.

Organization and Apprenticeship.—All professional education had its origin in apprenticeship. The novice learned by assisting a master—by doing. The master, in turn, recognized his responsibility in training the new generation which was to carry on the professional tradition and development. Later, when it was discovered that a very considerable part of this training could be reduced to principles and standards—to an orderly and logical formal presentation—schools developed. The school could teach these basic principles more effectively and in less time. It took over, in part, some of the burden of professional education; but apprenticeship, as we have noted, is still recognized as an essential factor in the educational process.

In earlier days the contact between master and apprentice was often very close and personal—approaching a father-son relationship. Today it is seldom indeed that one finds this contact still surviving. Modern organization, particularly functional organization and specialization, limits the contacts and experiences of the young engineer. Too many young engineers these days are placed in positions where the work is of a merely routine nature—a kind of glorified bookkeeping—that offers little or no opportunity for professional growth and development, as Professor Scott so well observed in these columns in the April issue.

We hear much of the need and demand for the broadly trained engineer, the young man of administrative and executive ability—capable, aggressive, and a "self-starter." These qualities may be apparent in a candidate's undergraduate work but can only be fostered and enriched through proper apprentice training. Probably the narrowness of some modern practice, as well as the narrowness of some of our engineering school curriculums is to blame for the apparent failure of American education to produce more capable, more broadly trained young men.

A Revival of Apprenticeship.—Clearly we need a revival of apprentice training—a determined effort on the part of mature engineers to conserve and develop the values of the old relationship of master and pupil. Our professional societies, it is true, are doing far more than in the past to guide the young engineer. Student chapters of our national societies, local section activities, the work of the E.C.P.D. for juniors, are all attempts to make not only better society members but better engineers. Yet the employer-engineer or the senior engineer in charge of young engineers cannot delegate his responsibilities to some professional group and forget about the problem. These responsibilities involve a personal obligation to the profession and to the men who must carry on tomorrow. Every master engineer should leave at least one pupil or protégé who will carry forward the higher ideals and standards of the profession.

The senior engineer should also see that promising young men are transferred from one department in an organization to another so that their experience may be varied and their abilities and capacity for responsibility broadened and developed. This plan is followed in many of the so-called apprentice courses that have been organized by engineering industries, but in other cases these courses too often offer merely special training for a routine technique.

Some engineering offices have also found it worth while to encourage staff meetings or colloquiums, for presenting papers, and for discussing reports and problems connected with the office. Junior engineers are thus encouraged to study the problems of the staff, are brought in contact with their seniors, and thus benefit from the mature advice and viewpoint of the experienced engineer.

School and Office.—Finally, it seems clear that the urban engineering school, through graduate offerings, is playing and will continue to play an increasingly important part in the postgraduate training of young engineers. Time was when the major advances in engineering theory came through practice. Today our engineering schools are producing more and more of the refinements and improvements in technique and design. Our civil engineering profession is not industrialized and organized to undertake modern research. The profession is turning to the schools for such work and the young engineer, already engaged in his apprentice training and anxious to secure special courses and information, turns to the centrally located, urban engineering school for this phase of his postgraduate training.

It also seems probable that it will be necessary in the future to attempt to restore some of the lost values in pre-professional practice by developing cooperative graduate courses in those engineering schools so located as to make this possible. In other words, practicing engineers may find it desirable to offer, through the facilities of the urban engineering school, some of the experience and advice which cannot be adequately developed under modern conditions of apprenticeship.

The basic element in apprenticeship is, however, the personal contact of master and pupil, and these suggestions, while helpful, cannot replace the personal efforts of those important professors of civil engineering, the practicing engineers. Many of our foremost engineers have long recognized these personal obligations and have earnestly and conscientiously endeavored to meet them. They apply to the consulting engineer and the employer-engineer, and also to the chief engineer and chief designer in the public or private engineering office. If our profession is to continue to develop well-rounded, adequately trained, professional men, we must not allow the rush of modern business and the adverse trends of modern organization to sidetrack or obscure the importance of cherishing and maintaining the basic educational values of true apprentice training.

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Value of "Light, Air, and Access" Easements

With Special Reference to Problems Arising in Connection with the Condemnation of Elevated Railroads in New York City

By E. De V. Tompkins
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What is the value of "light, air, and access" easements held in perpetuity by an elevated railroad when that road is condemned? In a recent New York City case, the answer was, "the original cost." Evaluating these easements by the method presented here, Mr. Tompkins arrives at a substantially lower figure. His argument is not presented as a criticism of the courts, but rather because he feels that their comments "indicate a regret that no theory of evaluation was available on which they could have depended for making a much lower award." He expresses the hope that "some legally competent person will so correct the defects in the argument" that the method he suggests may be submitted, in some future condemnation case, for action by the courts.

Recently, the Sixth Avenue Elevated Railroad in New York City was condemned at a cost to the city of $12,500,000. Included in this total was the so-called "light, air, and access" easement rights in perpetuity, on the abutting property. The value of this one item, as of date of condemnation, was found to be about $4,346,000. According to the method of valuation of such easements that will be explained in this article, the appropriate value for this was but $605,745, which would represent a saving to the city of $3,740,000 in this one case.

In any valuation, the first step is an examination of the property to be valued. It may be advisable, in the present discussion, therefore, to first examine the nature of these property easements.

The operation of an elevated railroad in a city street causes much noise, and the structure itself causes a loss of "light, air, and access" to the abutting property. These, and any other nuisances resulting from such a railroad will force a reduction in the rents receivable, and therefore in the annual income, from the abutting property. This constitutes a damage to the property, and as such use is not a normal street use, the company must compensate the property owner for the damage so caused, and the property is burdened with the easement, which gives the company the right to commit these nuisances. The theory is that the amount paid the owner will reflect the decreased value of the property, as evidenced by the price that will be paid by a subsequent owner for the property so burdened.

The company may secure such easement rights for nothing, or an exorbitant compensation may be demanded, depending on the individual property owner. Condemnation is therefore the usual procedure for their acquisition.

In this procedure, appraisals are based on the value of the property at the time of acquisition, and experts for both sides estimate the net annual return of the property adequately improved, first in the absence of the easement, and second when subject to the easement. The difference gives the annual loss due to the easement. The court weighs the relative merits of both appraisals and fixes the amount of annual loss.

The total amount of fair compensation to be awarded the property owner is fixed by determining what sum of money, at an appropriate interest rate, will yield each year for the life of the easement a sum equal to the annual loss of income from the property due to the taking of the easement right.

The life of the easement is of great importance. If at the time of acquiring such easements, the company had the ability to foresee that the useful life of the railroad would be but 30 years, or 60 years, and that thereafter further operation would prove unprofitable because of obsolescence, these easements would then be acquired for but 30 or 60 years. For, assuming the annual damage to a certain parcel of property to be $100, the total cost of the easement right for 30 years (at 6 per cent) would be $1,376, and for 60 years $1,616. The former amount will yield $100 every year for 30 years, and the latter $100 every year for 60 years. If the useful life had been known to be but 30 years, the easement right would have been acquired for that period only, at a saving of $240.

It is further to be noted that in a condemnation proceeding, the value of the easement right is fixed by the court for a certain time period. Of course, either side may appeal to the higher courts, but when the award is finally made, the value of the easement for that life is fixed and unalterable. Neither side could force a change in later years, on the grounds that the compensation from the award was proving either excessive or inadequate. The value of the easement right, for its life, has already been adjudicated.

It is obviously impossible to accurately determine the fair and reasonable compensation to be paid for the acquisition of such rights. Particularly is this true when the life of the easements extends over a long span of years. The Sixth Avenue Company (having its franchise in perpetuity) acquired these easements in perpetuity,

60 years ago, for $4,346,000. We are not here concerned with the accuracy or fairness of this amount of compensation—that has already been adjudicated. Our problem is as follows:

The company having exercised its right of damaging the abutting property for 60 years, and having paid $4,346,000 for so damaging it in perpetuity, what is the appropriate amount of compensation to be paid the company now, for terminating the life of these easements by right of eminent domain?

In the recent Sixth Avenue case, the company was paid back every cent of the original cost of these easements. Some months ago, awards were made in connection with the condemnation of the Sixth Avenue Elevated road from 53d to 59th streets, and also the 34th Street elevated spur. The awards were the original costs of these easements. The court indicated lack of conviction that the award was correct, but felt required to apply the same method as set forth by decision of the Appelate Division in the 42d Street elevated spur case.

PRECEDENT ESTABLISHED IN CASE OF 42D STREET SPUR

It was in this 42d Street case that the precedent was established of finding the value of property easements at the time of condemnation as equal to their original cost of acquisition 50 or 60 years before. And this method has been followed in all succeeding cases.

In the 42d Street case, the Court of Appeals upheld the Appellate Division in allowing mere junk value for the structure and no value whatever for the franchise. But as to these property easements, the court's opinion states: "In other words, the property in such easements, strictly speaking, is of no value to the railroads when the railroad ceases to operate and is taken out of the street, but the city should reimburse the railroads for what it cost them to acquire such easements, when it terminates the right of use in perpetuity."

In a dissenting opinion, one of the judges argued that the only possible value of these easements to the company lay in what has been called their "nuisance value," that is, in the opportunity that the company might have had to sell them to the abutting property owners, and that such a value, if it could be established, should be taken as the basis of compensation.

The company, of course, was contending for a much higher value. (In the recent Sixth Avenue case, it testified that the easements which cost a little over $4,000,000 sixty years ago would cost over $36,000,000 if acquired today.) The case was carried to the U. S. Supreme Court, the company contending that the award failed to grant the "just compensation" required by the Fourteenth Amendment. The U. S. Supreme Court affirmed the award of the New York courts, but in its decision, Justice Cardozo stated (without having occasion to decide the issue) that the state courts might have been overgenerous in allowing anything whatever for easement value.

The 42d Street spur was only a few blocks long, and the original cost of the easements was but a half million dollars, although the company was contending a value of many times that amount. Under such conditions, in the absence of a more rational method for their valuation in the evidence of the case, the court might well be "generous" enough to decide that, although these easements really have no value, it would consider their original cost of one half million dollars as their present value. But if this same method of valuation is to be applied in the condemnation of all the elevated lines in Manhattan and the other boroughs, this "generosity" becomes staggering, as their original cost is around $70,000,000.

Also to be considered is the "nuisance value" of these easements, or what the property owners might pay the company to be rid of them. There are probably thousands of parcels of property so affected. But even if one or more of these abutting owners were willing to pay the company, to get rid of the easements, 10 or 20 times as much as the company had paid them for their acquisition, such a scheme would be wholly impractical. For if the company removes its structure from in front of one parcel, the railroad can no longer operate and it must come down from in front of all parcels, and all owners will benefit. This being common knowledge, any attempt toward concerted action—to have all owners pay for the removal of the structure—would fail because the majority would do nothing themselves but would "let George do it."

There are many types of property the cost of which today might be 10 times that of 60 years ago, yet the value of ownership of which might not warrant paying today one-tenth of the cost price of 60 years ago. So with these easement rights; their acquisition today might cost 10 times as much as their original cost of 60 years ago, but their possession might be of no value whatever. Their far greater cost of acquisition today only proves that the abutting property owners now suffer a damage that was most inadequately compensated for by the original payment.

These rights are for a specific use of a specific structure, and their purchaser, to exercise them when acquired, must also purchase the entire complex railroad property. These rights are an absolutely necessary part of the entire railroad property, yet their cost is but a small fraction of the total cost. If such property has become an obsolete means of transportation, and its present owner cannot profitably operate it, it is to be assumed that no other owner could, and therefore that these easement rights are valueless.

In the absence of any other means of valuation, the original cost of a property may possibly show its actual worth at the time of its purchase, and evidence of this may be given much weight as to its present value, provided its purchase was recent. But should this method of determining present value apply to a property acquired 60 years ago, and where such property consists of the right to commit a damage to the real property of others, for a period of time, and has been so used constantly for 60 years?

SUBMITTING A NEW THEORY OF VALUATION

In view of the previously quoted decisions of our highest courts, it seems somewhat audacious for a mere engineer to submit a contrary theory of valuation. The writer by no means intends a criticism of the courts. He feels that their comments in the decisions indicate a regret that no theory of valuation was present in the evidence of the case, on which they could have depended for making a much lower award for these easements. When one so eminent as Justice Cardozo states that any allowance of value for these easements might have been "overgenerous," an attempt to provide a theory to substantiate this statement cannot be considered criticism.

Under four different assumptions, the present value of such easements when condemned long after their acquisition will now be determined on the basis of the present worth of annuities, 6 per cent being assumed as a proper interest rate.

First Problem. After 20 years of existence, an elevated railroad property is condemned. The court finds its physical property has only a junk value, and its franchise, though still being operated, is worthless. Its

"light, air, and access" property easement rights were acquired for a 50-year period, for the sum of $94,571. What is their value now, when condemned?

Solution. Had they been acquired for but 20 years, their cost would have been $68,819; or for 20 years' use of these rights an excess payment of $25,752 was made 20 years ago. The railroad company is therefore entitled to a refund of this excess payment, together with interest on it for 20 years, making the present value of the easements $56,654.

LIGHT AND AIR RETURN TO SIXTH AVENUE, NEW YORK, WITH THE PASSING OF THE "EL"
Looking North from Waverly Place—Demolition in Progress

Second Problem. Assume all conditions to be the same as in the first problem, except that condemnation occurs 50 years after acquisition. What is the value of the easements now, when condemned?

Solution. It is obvious that as condemnation occurs on their expiration date, these easements cease to exist, and therefore have no value.

Third Problem. Assume that the same easement rights were acquired in perpetuity for $100,000, that condemnation occurs 50 years after acquisition, and that all other conditions remain the same as before. What is the value of the easements now, when condemned?

Solution. Had they been acquired for only 50 years, their cost would have been $94,571; or for but 50 years' use of these rights an excess payment of $5,429 was made 50 years ago. The railroad company is therefore entitled to a refund of this excess payment, together with interest on it for 50 years, making their present value $21,716.

Fourth Problem. Assume all conditions as in the third problem except that there is no condemnation, but that the company itself, realizing that the railroad has outlived its usefulness and can no longer be operated at a profit, voluntarily decides to cease operation and to liquidate its assets. What is the value of these easement rights?

Solution. It is under these conditions that, as Justice Cardozo stated, it might be "overgenerous" to allow anything whatever for easement value.

It is to be noted that in the first three problems, the "original cost" is the basis for determination of the present value. This is because the value of these easements for their stated life had already been adjudicated. However, if by right of eminent domain, their stated life is shortened, then their original cost must be the basis of calculation of their appropriate present value due to this shortened life. Of course, if the conditions were not as assumed (and as found by the courts), but the railroad were earning abnormally large profits, the total value of the railroad property could be determined by a capitalization of these profits. Then, keeping all other items of the total property at their actual cost, all the excess value could be allocated to these easements, thus making their apparent value to a new owner of the railroad property far greater than their original cost to the present owner.

Consider now the assumed conditions of the second and third problems. One company has sufficient wisdom to know that the useful life of its railroad will be but 50 years, and therefore acquires its easement rights for only $94,571. The other company, not having such wisdom, spends $100,000 to acquire the same rights in perpetuity. About 50 years later, when both are condemned, it is found for each that the railroad structures have only a junk value, and their franchises are worthless. If the easement rights for the first company are correctly found to be worth nothing, then this is but "the end of a perfect day" for this company. But if these rights for the second company, instead of being valued at $21,716 in accordance with the preceding solution, are found to have a value equal to their original cost and the company is paid back in full ($100,000), then surely "where ignorance is bliss, 'tis folly to be wise."

APPLICATION OF METHOD TO SIXTH AVENUE "EL" CASE

Applying the writer's method to the recent Sixth Avenue Elevated case, the solution is as follows. The original easement cost in perpetuity was $4,346,000. The condemnation limits the useful life to but 60 years. Had the easements been acquired for only 60 years, their original cost would have been $4,214,316; hence sixty years ago the company made an excess payment of $131,684. It is therefore entitled to a refund of this excess, with interest thereon for 60 years. Thus the appropriate present value of these easements is $605,745.

As the award was $4,346,000, the saving to the city by this method would have been $3,740,000.

The writer is aware that many apparently satisfactory appraisals of "light, air, and access" easements are made by those entirely unfamiliar with the present worth of annuities; that some appraisers make additional allowances, for such things as the effect on marketability due to the easement; also, that the principal of an annuity in perpetuity is not decreased by the annual payments it yields. But a discussion of these now is not considered essential.

It may be unnecessary to state that the writer is ignorant of the possible legal obstacles to the adoption of this suggested method of valuation of easements, when the property is condemned years after their acquisition. While the awards in the cases already decided may not now be changed on the grounds of mathematical error in their determination, it is hoped that some legally competent person will so correct the defects in this argument, and so utilize the ideas here suggested, that in future condemnation of existing easement rights for elevated railroad purposes, this method of appraising their present value may be submitted for action by the courts.

If such action is favorable, then when all of New York City's elevated roads have been condemned, the city instead of paying the "original cost" for all these easements (say $70,000,000), will have paid but $10,000,000.

Safe Foundation Depths for Bridges to Protect from Scour

Study of Failures Caused by March 1938 Flood in California Yields Valuable Data

By Ralph W. Stewart

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The science of applied mechanics has been highly developed with reference to the analysis of stresses in bridge members, enabling a designer to work quite accurately to a predetermined factor of safety. The depths of bridge foundations, however, must be fixed largely by judgment based on experience and precedent, as the factors involved seldom, if ever, permit these depths to be satisfactorily obtained by mathematical analysis.

Records of failures due to scouring of the bottoms of flooded channels to a depth that disturbed bridge piers are therefore valuable as a guide to engineers. The March 1938 flood runoff in southern California undermined the supports of numerous "permanent-type" bridges and offered an opportunity to collect the data presented here relating to unsafe foundation depths.

Scour Failure of an Abutment
The Whitsett Avenue Bridge Over the Los Angeles River

A general characteristic of the region involved is that the streams have steeper slopes and higher velocities than those usually encountered elsewhere because of the comparatively short distance between the ocean and the mountains. The stream beds, as would be expected from the high velocities, are usually composed of rather coarse material. Some of the streams, just before reaching the ocean, cross flat salt marshes of large area. Between these marshes and the ocean is a narrow strip of sand dunes along which the coast highway passes, with bridges over the stream outlets. These streams go dry in summer, and sand deposited by the

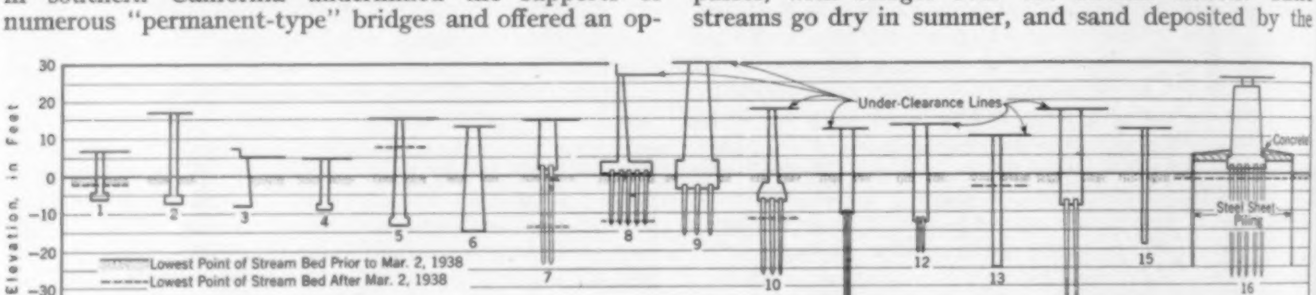

Fig. 1. Diagrammatic Cross-Sections of Piers and Abutments That Failed by Scour in the March 1938 Flood (California)

Table I. Data on Bridges Shown in Fig. 1

Item No.	Name and Location	Type of Structure	Length of Adjacent Clear Spans in Ft at 90° to Channel	Character of Stream Bed	Cause of Failure
1	*Cucamonga Wash Br., San Bernardino Co.	Concrete without piles	15	Sand and gravel	Scour
2	Malibu Creek Br., Coast Highway	Concrete without piles	30	Sand with some gravel	Scour augmented by drift and debris
3	*Ventura Riv. Overflow Br., Coast Hw'y.	Concrete without piles	28	Sandy gravel	Scour
4	*San Antonio Creek Br., 5th St., Pomona	Concrete without piles	27	Sand with some gravel	Scour
5	Huntington Dr. Br., Eaton Wash.	Concrete without piles	20	Gravel wash	Scour
6	Pac. Elec. Ry., Glendora line, San Gabriel Riv.	Concrete without piles	50	Heavy gravel and boulders	Scour
7	Santa Ana Riv. Br., Coast Hw'y, Orange Co.	Concrete with piles	60	Dune sand	Scour
8	Whitsett Ave. Br., Los Angeles Riv.	Concrete with piles	40	Hardpan	Scour
9	Southern Pac. R.R. Br., Los Angeles Riv.	Steel plate girders, conc. piers, with piles	70	Gravel with some boulders	Scour
10	*Lankershim Blvd. Br., Los Angeles Riv.	Conc. with piles	40, 20	Sand and gravel	Scour somewhat augmented by debris
11	*Santa Clara Riv. Br., Bardsdale, Calif.	Reinf. conc. and steel truss, conc. piers, with piles	129, 30	Sand and gravel	Scour materially augmented by debris
12	*Santa Clara Riv. Br., Saticoy, Calif.	Steel truss, conc. piers with piles.	129	Sand and gravel	Scour materially augmented by debris
13	*Santa Ana Riv. Br., 4 Mi. So. of Yorba Linda	A-frame trusses on conc. pile bents	40	Sand and gravel	Scour materially augmented by debris
14	Santa Ana Riv. Br., Norco, Calif.	Timber trusses, steel cylinder piers, piles	46, 60, 120	Sand and gravel	Scour materially augmented by debris
15	Sespe Overflow Br., Ventura Co. Road to Castaic	Timber stringers on conc. framed bents	30	Sand, gravel, and boulders	Failure due principally to debris
16	A.T. & S.F. Ry. Br., L.A. Riv. near No. Broadway	Steel trusses and plate girders	30, 80	Sand, gravel, and boulders	Failure due principally to scour

* Water rose above bottom of deck.

surf and the wind closes their outlets. During the next runoff, lakes form above the bridges and when the water breaks through to the ocean sufficient velocity may be developed to do considerable scouring before the head is exhausted. This action is intensified at bridges having narrow waterways.

In Fig. 1 is shown a diagrammatic cross-section illustrating a number of piers or abutments which failed by scour in the March 2, 1938, flood runoff in southern California. The ground line used as the base of this diagram represents the elevation of the lowest point in the channel relative to the elevation of the pier. It is not the bottom of the channel adjoining the pier, except in cases where the pier location happens to coincide with the extreme low point in the channel. The data for channel bottom elevations are from the latest observations available, which in some cases were taken shortly before the flood and in other cases date back several years and consequently may be subject to inaccuracy due to scour which may have occurred in the interim. Where an observation was made immediately after the flood, and before resilting of the channel was complete, it shows on the diagram below the regular ground line but does not necessarily indicate the full depth of scour, as some silting may have occurred before the observation was made.

Fig. 2. Failure of Southern Pacific Railroad Bridge Over Los Angeles River

Table I contains pertinent data relating to the 16 cases shown in the diagram. The last column gives the writer's opinion as to the cause of failure and is based on inspection and general knowledge of the stream as well as on the data presented.

The view of Bridge No. 9, shown in Fig. 2, was taken looking downstream after the flood had subsided. In the background is seen the new Figueroa Street Viaduct, which was not damaged; its pier footing extends 22 ft below stream bed and wooden piles penetrate from 12 to 16 ft below that.

A view of Bridge No. 11 after the main flood had subsided is shown in Fig. 3. The gap left by washing away nine 30-ft spans and the erosion of the bank for an additional 40 ft of width appears in the foreground. None of the 129-ft spans failed. The scour under the shorter spans was increased by water syphoning at increased velocity under the debris which lodged on the piers. Also, the lateral pressure of water against debris was more effective in displacing the smaller piers.

Bridges 1, 2, 3, and 4 in Fig. 1 show inadequate depth of foundations to resist scour; 5 and 6 indicate that even a depth of 15 ft below stream bed is likely to be insufficient for safety where the current is swift; 7, 8, and 9 show that a shallow foundation is likely to be scoured out even though supported on piles (note Fig. 2). Bridges 10 to 15 show the powerful effect of scour and debris combined, and indicate that reliance cannot be placed on concrete piers of the depths shown even though supported on long piles. Figure 4, illustrating Bridge No. 7, shows a typical scour failure is dune sand.

The recent policy of the Atchison, Topeka, and Santa Fe Railway Company is to keep its footings not less than 25 ft below stream bed, and its bridges made a very good showing in withstanding the effects of the March 1938 storm. In one case, however (Bridge No. 16), surrounding a pier by steel sheetpiling 25 ft deep failed to save it. Some previous experience of this company showed that pier depths of 15 to 18 ft in high-velocity streams having heavy gravel and boulder beds do not give assurance of resisting scour.

Several bridges which washed out are not entered in this report because factors other than the depths of their foundations were of importance; therefore using them as data would not add to the accuracy of the conclusions.

CONCLUSION DRAWN FROM THIS STUDY

It is seen that in many of the larger southern California streams having beds of sand or gravel, foundation depths of less than 20 ft without piles do not give perfect assurance of safety; and that even with pile sub-foundations the depth cannot be substantially reduced. This conclusion will of course be inaccurate for many individual bridge sites, and local conditions will be a factor in modifying any general rule.

Data and photographs for this paper were obtained through the courteous cooperation of the engineering staffs of the Atchison, Topeka, and Santa Fe Railway, the Southern Pacific Company, the Pacific Electric Railway Company, the California State Highway Division, and the County Engineer of Orange County, California.

Fig. 3. Nine 30-Ft Spans of the Santa Clara River Bridge at Bardsdale Were Washed Away, Though Spans Did Not Fail

Fig. 4. A Typical Scour Failure in Dune Sand; the Santa Ana River Bridge on the Coast Highway

A Modern Building Code—Arrangement and Organization

By D. S. Laidlaw

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Much has been done in recent years to improve the technical content of building codes and to make them reasonably standardized, clear, and easy to enforce. But much remains to be done, says Mr. Laidlaw, in improving their organization and arrangement. Accordingly he deals in this article with the principles of sequence, subdivision numbering, wording, and format, always keeping in mind the aims of making the contents of the code as accessible as possible to users, and providing for future revision and expansion. His recommended sequence follows the main steps that must be taken in planning a building, from architecture through engineering to contracting. He presents a plan for subdividing and numbering the various sections so as to provide for future revision and expansion, and concludes with suggestions on the type of organization best suited to the work of preparing or revising a code.

THE amount of attention that has been focused in the last few years on the technical requirements of building codes, in the United States and Canada, has brought about extensive revisions of the codes of most cities, and has resulted in the production of several model codes or parts of codes. Perhaps no individual has contributed more to the literature of the subject than Dr. Robins Fleming, another article by whom appeared in the November 1938 number of Civil Engineering. Notable mention should also be made of the reports of the Building Code Committee of the U. S. Bureau of Standards, the Model Building Code prepared by the National Board of Fire Underwriters, and the Pacific Coast Uniform Building Code, written by the Pacific Coast Building Officials' Conference. The result of all this work is seen in the increasing uniformity and reasonableness of building code regulations over the whole continent.

A careful study of the most modern building codes, however, and of many reports and articles upon the subject, begun by the writer in 1932, disclosed the fact that proper principles of arrangement had not received the study they deserved, and their formulation was undertaken as the first task of the committee of which he was chairman. This editorial committee, of an organization set up to revise the building code of the City of Toronto, has studied and worked with these principles for several years. A discussion of them, and of other related matters, may be of interest and help to those setting out to write or revise a code.

NEEDS OF USERS MUST BE CONSIDERED

In writing a book it is wise to consider the needs and tastes of prospective readers, and this is no less true of a building code. A code is a reference book, never read straight through, or for pleasure, but only read under pressure, for an immediate need, and fragmentarily. It is most important, therefore, that the material be so arranged that the reader can readily find the information he requires.

Users of a code fall into two classes, habitual and occasional. The only really habitual users are building officials, and they can put up with any system, or lack of system, of arrangement, because they almost know their own codes by heart. It is not uncommon to find officials who have memorized whole chapters of their code. It would be interesting to determine how much of the time of any official's office is spent in showing the public where to find information in the code.

The general public are the occasional users, and since the whole municipal government exists for their comfort and security, it is not unreasonable to suggest that their convenience should govern the arrangement of the code. Of the public, however, the majority seldom need the whole code at once, and many could get along to advantage with a code in pamphlet form. Architects and some engineers, however, need the whole code. It is suggested that a consideration of the progress of a building project through an architect's office, and a study of the kind of information needed by him at each step, should provide a sound basis for arranging a building code. The project should be thought of as being in a distant city, which has a code the architect has never seen before.

ORDER OF USE OF CODE PROVISIONS

Assume, for example, that the architect has a given piece of land on which he must erect a building to house a certain enterprise. Whether this enterprise is a small or a large family, a mercantile or manufacturing business, a club, or a bank, the problem is essentially the same.

The first thing he seeks to know is the authority of the code, and what his duties and powers, and those of the administering officials will be under it. Next he wants definitions, for it must be remembered that usage of English, particularly in the building trades, varies widely from place to place. He will not want all the definitions at once, nor will he ever need them all on any one job, but he will look for them near the beginning of the book, and is entitled to find them there.

His third need is to know whether or not he will be permitted to use the land for the enterprise suggested and, that question favorably answered, what restrictions its use will impose on the shape, size, materials, and cost of the building. These matters are commonly referred to as "zoning restrictions," and while they are often considered as a separate ordinance, and some times even embodied in a large number of separate ordinances or deed restrictions, they are an essential part of any properly compiled code.

Having determined the maximum envelope of his building, and eliminated the types of construction prohibited for its location, the architect proceeds to make sketch plans. At this stage he looks for the restrictions placed on his plans to suit the hazards and necessities of the enterprise he has to house. These "occupancy restrictions" may eliminate other types of construction, and impose different limitations on height and area, but

they will also lay down rules for maximum and minimum room sizes, requirements for light and air, necessary laboratory accommodation what fire separations must be built in, and size and type of exit facilities. In many of the old codes this information was distributed quite widely throughout the book, but in newer ones the necessity of collecting it all in one place has been generally recognized.

One thing remains necessary to complete the general planning of the building—the final determination of the particular type of construction to be adopted. While the first two classes of "general planning restrictions" have served to eliminate prohibited types of construction, first for the location, and second for the enterprise to be housed, a final choice must be made, based on questions of economics or particular suitability to the enterprise. The architect would appreciate finding the different types in common use defined, and the limits to their use presented and compared, so that he can intelligently make his final choice.

If the project goes through, then and then only will the architect need to have the live loads for which he must design the building, along with the mass of detailed regulations that must be observed in the use of the many different building materials. This information, generally forming the original and the bulkiest material of a code, has had more of the attention of revising bodies than any other. It is at once the easiest part to revise and the part requiring most frequent revision and expansion.

It has been found, however, that a considerable saving of space and increase in simplicity can be attained by setting up standards for many features of building operations and constructions. Fire-resistive standards, capable of giving protection against a standard fire for definite periods of time, are coming into use, and there are many other features of buildings that might be similarly standardized, such as egress facilities, and heating and ventilating requirements. As those matters are particularities of construction rather than generalities of planning, the architect will look for them late, rather than early, in his search for information. Consideration of the excavation, construction, and demolition practices allowable, as they principally concern contractors, who are usually the last ones called in on a project, will be looked for at the end of the code.

The arrangement suggested is followed, in general, in the Pacific Coast Uniform Building Code, whose writers deserve all possible credit for having, so far as the writer is aware, originated the system. The arrangement follows the main trend of thought, from architecture, through engineering, to contracting, that is involved in nearly all construction—neglecting, of course, the numerous jumps back and forth that the mind always makes when planning a building. A skeleton of such a code is indicated in Table I.

Table I. General Arrangement for a Model Building Code*

1. Administration
   - 1-A. Title and scope
   - 1-B. Duties and powers
   - 1-C. Enforcement and penalties
2. Definitions
3. Zoning Restrictions
   - 3-A. Limits of zones
   - 3-B. Restrictions in Zone I
   - 3-C. Restrictions in Zone II
   - Etc.
4. Occupancy Restrictions
   - 4-A. Classification of types of occupancy
   - 4-B. Restrictions for Type I occupancy
   - 4-C. Restrictions for Type II occupancy
   - Etc.
5. Types of Construction
   - 5-A. Classification of types of construction
   - 5-B. Type I construction
   - 5-C. Type II construction
   - Etc.
6. Loads
   - 6-A. Dead loads
   - 6-B. Live loads
7. Materials and Stresses
   - 7-A. Soils and footings
   - 7-B. Masonry
   - 7-C. Reinforced masonry
   - 7-D. Reinforced concrete
   - 7-E. Composite, steel and concrete
   - 7-F. Structural steel
   - 7-G. Structural aluminum
   - 7-H. Cast iron
   - 7-I. Wood
   - 7-J. Plaster
   - 7-K. Plumbing and drainage
   - 7-L. Roofing
   - Etc.
8. Fire-Resistive Standards
   - 8-A. Protection of structural members
   - 8-B. Fire-separation walls
   - 8-C. Fire-separation floors
   - 8-D. Fire-resistive roofs
   - 8-E. Protection of openings
9. Means of Egress
   - 9-A. Passages and doorways
   - 9-B. Stairs and ramps
   - 9-C. Elevators and dumbwaiters
   - 9-D. Escalators and conveyors
   - 9-E. Slides
10. Heating and Ventilating
    - 10-A. Boiler-room standards
    - 10-B. Chimneys and flues
    - 10-C. Stoves and ovens
    - 10-D. Duct systems
11. Signs and Billboards
    - 11-A. Ground signs
    - 11-B. Roof signs
    - 11-C. Wall signs
    - 11-D. Hanging signs
    - 11-E. Marquises
12. Encroachments over Public Property
    - 12-A. Subsurface encroachments
    - 12-B. Encroachments above ground
13. Construction Practices
    - 13-A. Excavation
    - 13-B. Construction
    - 13-C. Demolition

*This arrangement follows the proposed Toronto Building By-Law in general, but not necessarily in detail.

It is not sufficient that the material of the code be well arranged. If a code is to remain useful, provision must be made for future revision, and for additions, without upsetting the arrangement of the whole and without the necessity of revising the numerous cross-references. The only system that will satisfy these conditions is one based on the principle of successive subdivision. Each major division of the material must be split into general topics, each of which in turn is again split up into more specific titles, and so on down, always subdividing generalities into particularities. A skeleton arrangement of one small section of a code, shown in Table II, demonstrates how this principle can be carried out to the last detail.

This method of numeration is something of a novelty. The Pacific Coast Uniform Building Code, while arranged in a most logical manner, is felt to be faulty in its system of numeration. In it the major divisions each contain several chapters, and as the chapters are numbered consecutively throughout the book and independently of the parts, it would prove exceedingly difficult to add a chapter to any but the last of the parts. Provision for such future expansion should not be thought a mere academic necessity, for within recent memory, reinforced concrete has come into use, and reinforced brick masonry and structural aluminum are coming into use today.

Paragraph Numbering Schemes That Provide for Easy Expansion of Code

In the Pacific Coast Code, as in the National Board of Fire Underwriters' Code, the paragraph or section numbers include the chapter numbers, the former taking the units and tens, and the latter the hundreds and thousands. Thus, Section 2106 would be Section 6 of Chapter 21, partially fulfilling the condition laid down. Some of the more recent codes have used a complete decimal system which admirably follows the principle of successive subdivision, but which, the writer feels, contains certain undesirable features. Under that system, a decimal point is written in the number every time a subdivision is made. Thus 6.11.18.4.3 would be the third division of the fourth, of the eighteenth, of the eleventh, of the sixth major division. Room is provided for expansion at every step, and yet the smallest paragraph can be identified with a single number that positively locates it. The writer suggests, however, that letters be substituted for alternate numbers, since the

whole number then becomes easier to pronounce and is less likely to be misread. Thus the number just given becomes 6-K-18-D-3. The writer is indebted to the filing system proposed by the American Institute of Architects a few years ago, for the germ of the idea for the system.

IMPORTANCE OF PRINTED FORMAT

Printed format is only slightly less important than arrangement and numeration. It goes without saying that the size of sheet and thickness of paper chosen should be such that the book can be carried in the pocket. It is possible to make the code almost self-indexing by printing the titles to the subdivisions of the third and lower orders in the outside margin, using separate fonts of type for each order. When to this is added a really comprehensive index and such refinements of detail as would suggest themselves to a committee, it should be possible to produce a code that will present no difficulties to any earnest searcher after information. Keeping in mind the necessity of periodic revisions, page numbers should be as inconspicuous as possible, and all references should be to subdivision numbers. The method of numeration makes it possible to drop from the finished book all names for the different orders of subdivisions, although they have been found very useful in the early stages of writing a code.

TABLE II. SUBDIVISION OF A TYPICAL CHAPTER*

- 7-F. Structural Steel
  - 7-F-1. Definitions
  - 7-F-2. Physical Requirements
    - 7-F-2-A. General
    - 7-F-2-B. Special steel
    - 7-F-2-C. Unidentified steel
    - 7-F-2-D. Condition of steel
  - 7-F-3. Tests and Inspection
  - 7-F-4. Permissible Stresses
    - 7-F-4-A. Medium structural steel
    - 7-F-4-B. Other steels
    - 7-F-4-C. Application of formulas
  - 7-F-5. Compression Members
    - 7-F-5-A. Limits of l/r
    - 7-F-5-B. Unsupported length
    - 7-F-5-C. Various types of loading
    - 7-F-5-D. Use of special column details
    - 7-F-5-E. Continuous columns
    - 7-F-5-F. Special conditions
    - Etc.
  - 7-F-6. Flexural Members
    - 7-F-6-A. Effective spans
    - 7-F-6-B. Continuity
    - 7-F-6-C. Allowable stress in compression flange
    - 7-F-6-D. Lateral support
    - 7-F-6-E. Maximum deflection
    - 7-F-6-F. Vertical crippling stress on web
    - Etc.
    - 7-F-6-I. Plate girders
      - 7-F-6-I-1. Thickness of web
      - Etc.
  - 7-F-7. Anchorage and Bearing
  - 7-F-8. Rivets and Bolts
  - 7-F-9. Welding
  - 7-F-10. Steel Joist Construction
  - 7-F-11. Erection Requirements
  - 7-F-12. Cleaning and Painting

*This arrangement is substantially that of the Structural Steel Chapter now in use in the Toronto Building By-Law, but includes "Welding," which is not now in use, and omits certain matters that will ultimately be removed when the by-law is completely revised.

A word should be said on the subject of terminology. That it should be explicit and simple is apparent to all; that it should be consistent throughout is, to judge from some of the recent codes, not so widely understood. Inconsistent terminology has an odd knack, after the passage of time, of appearing intentional, and the courts have been known to attach the most important meaning to so small a thing as a missed or misplaced comma. In so large a work, consistency can only be obtained by putting the writing, for practical purposes, in the hands of one person, and this leads directly to a consideration of the organization necessary for a code.

FULL-TIME PAID ASSISTANT

In the reports of the U. S. Bureau of Standards, the suggestion is made that the services of a consulting engineer skilled in the subject be retained, and that, with the aid of an advisory committee, the writing of the code be left in his hands. The writer would like to suggest certain modifications of this arrangement, based on his experience. It should be noted that revisions to a building code are generally undertaken only in hard times, and the initiative is usually taken by its users rather than by its administrators. Under such circumstances, funds with which to engage a consultant are generally lacking, and therefore an attempt is made to handle the whole undertaking by voluntary effort. This attempt usually breaks down badly as soon as there is the least improvement in business, whereupon it becomes necessary to engage full-time assistants. Having been involved in just such an attempt, the writer is keenly aware of its unsatisfactory, even unpleasant, features. It should be recognized from the start that a full-time paid assistant should be employed.

The full-time assistant should be the secretary of the committee, and incidentally of any subcommittees it may set up. He need not be a man of very wide construction experience. It is sufficient that he be familiar with construction language, and well enough grounded in the fundamentals of engineering to set down the committee's ideas clearly on paper. An engineering graduate of four or five years' standing should have sufficient technical knowledge, and yet sufficient inexperience, to bear in mind constantly that he is not writing the code himself, but is only the instrument through which others are writing it. It is however vitally important that he be a master of English. Perhaps it should also be mentioned that he should have a clear head. Without this he will put the whole organization into a muddle before he is well started, and they may never get out of it.

Such a secretary, acting on every committee, handling all correspondence, keeping accurate minutes of all meetings, preparing many of the reference data, and doing the actual writing of all drafts, can be of the utmost use. Having all drafts prepared by one hand, and that an expert one, saves so much of the time of an editing committee that their work, from being the largest single task, becomes one of the smallest; for the editing of a badly written and badly arranged draft is one of the most difficult and, in a business way, dangerous tasks that may well fall to the lot of a committee. Again, the secretary, being on all committees, can transfer from one to another the many suggestions each will have to make, and can keep them all at work steadily so as to bring the completed code into being within a reasonable time, and before the interest of the many individuals concerned begins to flag. Given an adequate, but not necessarily large, salary, and sufficient office accommodation and help, he should be able to make a good name for himself and serve his community to its lasting advantage.

ARRANGEMENT, NOT TECHNICAL CONTENT, THE PROBLEM

While it is perfectly true that the best written and most logically arranged code would still be vexatious, onerous, or laughable, if the content were not suited to its community or in line with modern engineering practice, such a code is most unlikely ever to be written. What is more commonly found is a code that, based on the latest technical information, is so badly arranged and sloppily written that it is difficult to follow, hard to understand and, occasionally, turns out to say something very different from what was intended by its drafters. The writer remembers seeing the word "to" changed to "by" in the customary live-load reduction formula for columns in one code, with ludicrous results.

Large Plants for Aggregate Production

Fourth of a Series on Modern Construction Tools and Practice

By M. P. Anderson

Associate Member American Society of Civil Engineers

Chief Engineer, Brown and Root, Inc., and McKenzie Construction Company, Marshall Ford Dam, Tex.

ONE of the factors markedly affecting the cost of a concrete dam is the availability of suitable aggregate. How such material is produced today, in large quantities and at low cost, is told here. As examples of modern practice Mr. Anderson selects the rock-crushing plant that was used to produce sand for Norris Dam, and the sand and gravel processing plants for the Marshall Ford and Grand Coulee dams—which cover a wide range of conditions, and with all of which he has had personal experience. The one factor contributing most to a low cost of aggregate, he says, "is the ability of a plant to produce continuously at a high rate." Hence the wisdom of the trend toward the installation of better machinery—"rugged, heavy-duty units of ample capacity and proved performance."

MUCH progress has recently been made in the processing of raw materials, at high rates of production and low cost, to meet specifications covering the grading of aggregate. Especially is this true in the case of fine aggregate or sand; recent activity in dam construction has developed the contractor's sand plant to the point where it is the most important unit of the aggregate producing system.

The general belief that a sand manufactured from rock is likely to be harsh and to produce a concrete difficult to place is not without basis, but experience on at least one large dam indicates that good concrete sand can be made from suitable rock if the proper machine is used for the crushing process. Again, deposits of natural sand having unsuitable gradings have been processed in a number of ways to produce an acceptable product. Mining machinery long used in the grinding and classification of ores has come to play a part in this work.

The trend in modern plants for aggregate production is towards better machinery, the extensive use of belt conveyors, the interlocking of electrical controls, and (for the larger plants intended for several years' service) the structural use of concrete and steel. Few changes have been made in the general run of jaw and gyratory crushers for some years; the better makes continue to give satisfactory results. A machine used for secondary crushing at the Norris Dam plant, although not entirely new, possesses certain advantages over the ordinary gyratory crusher used for secondary reduction. This is the cone crusher, so called from the shape of the crushing head, whose base provides a large annular crushing area near the point of discharge. Compared with other crushers of equal weight, this machine has much more capacity and will do finer grinding than the gyratory. Also, the size of the product can be changed by an adjustment that can be made while the machine is in operation.

Multi-deck vibrating screens are replacing the revolving type for general use because of the higher efficiency, economy, and compact arrangement possible with this type. The revolving type is largely used for scalping operations where oversize pieces in the pit run of material are to be separated and crushed. The horizontal type of vibrating screen as opposed to that with an inclined deck is coming into favor. Advantages are lower headroom and a simpler and more rugged vibrating element. The eccentric-shaft vibrating mechanism used on the inclined type of screen is replaced by a self-contained vibrating unit attached to the screen frame. This unit contains two unbalanced weighted shafts which revolve to impart the necessary motion to the screen cloth. Excellent results are being obtained at the Marshall Ford Dam plant with two of this type making a $^3/_{16}$-in. and a $^3/_4$-in. separation.

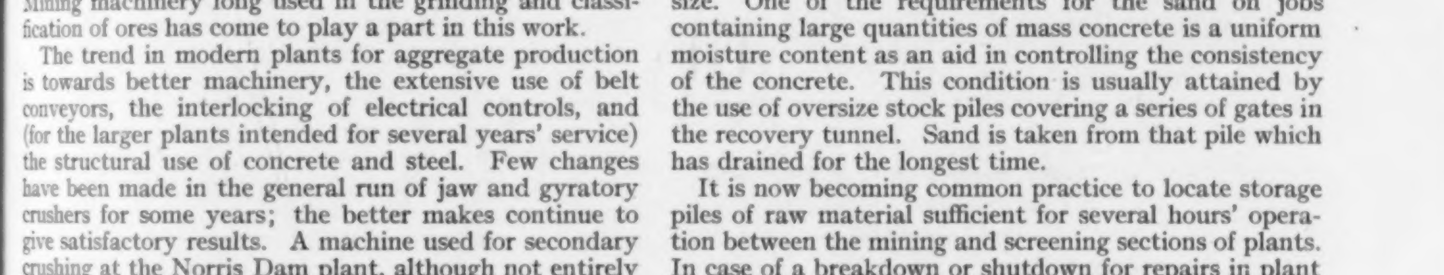
In stockpiling the heavier sizes of aggregate, 3- and 6-in. maximum, attention is given to the breakage of material by fall. Stone ladders and chutes of gentle inclination are employed to minimize such diminution in size. One of the requirements for the sand on jobs containing large quantities of mass concrete is a uniform moisture content as an aid in controlling the consistency of the concrete. This condition is usually attained by the use of oversize stock piles covering a series of gates in the recovery tunnel. Sand is taken from that pile which has drained for the longest time.

It is now becoming common practice to locate storage piles of raw material sufficient for several hours' operation between the mining and screening sections of plants. In case of a breakdown or shutdown for repairs in plant or pit, these piles furnish feed for the screening section, or an outlet for the product of the mining section.

THE TWO METHODS OF SAND CLASSIFICATION

In the classification process the separation of a sand is usually accomplished in one of two ways—by screening or by hydraulic separation. There are many types of hydraulic equipment but the principle is about the same in all and can be simply expressed as follows: Water and sand enter a compartment where the velocity of the stream is slowed by enlargement of the channel and some or all of the sand is settled out, the water escaping by an overflow weir. The settled sand may be raked out by a continuous drag, reciprocating rakes, or a screw, or it may be

Aggregate Plant at Norris Da



START OF MINING OPERATIONS IN GRAND COULEE DAM PIT
5-Yd Shovel Loading Self-Propelled Hopper at End of Conveyor Boom. Raw Material Storage Pile Is Out of Sight at Far End of Trestle

drawn from the bottom by a valve, as in the case of conical tank separators.

Both screens and hydraulic separators are used for sand classification in aggregate plants, but the majority of installations favor the hydraulic method. Screening is successfully employed down to about a 10-mesh separation, but below this point the screen area required may become prohibitive and operating troubles due to blinding and cloth changes are likely to become serious. Although screens may effect a sharper separation, it is probable that, for a graded material such as concrete sand, a zone of separation is more to be desired than a sharp cut. Furthermore, wet screening is usually necessary, and this means that the sand must be dewatered for handling purposes after it has passed the screens. On the other hand, the discharge from hydraulic classifiers can be handled on a belt conveyor without further treatment. In the hydraulic process the recovery of fines or material in the 100-mesh zone is apt to prove difficult under some conditions, and this problem should be given attention when installing sand washers and classifiers.

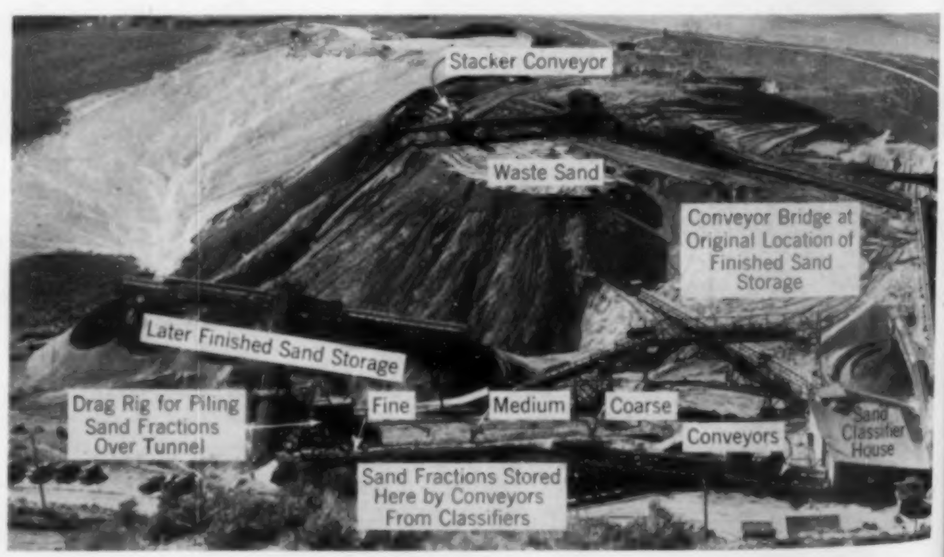
Three aggregate plants built for recent construction and for work now in progress cover a wide range of conditions as regards source of raw material, equipment employed, and plant capacity. These are the rock crushing plant for Norris Dam, and the sand and gravel processing plants for the Marshall Ford and Grand Coulee dams. The more outstanding features of these construction units will now be described.

HAMMERMILL CRUSHERS FOR SAND AT NORRIS DAM

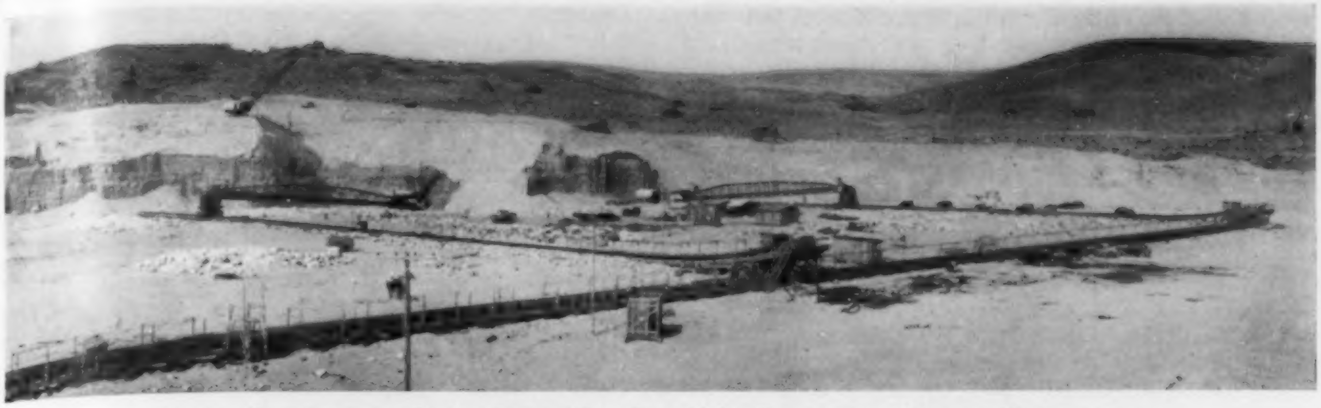
Experience with the sand plant at Norris Dam indicates the necessity for thorough investigation and actual tests of the quarry rock in various crushing machines before such equipment is purchased. The quarry rock was a dolomite containing from 2 to 6 per cent of silica. Sieve analyses of the products of various crushing machines disclosed the fact that all produced a sand which, when compared with the grading desired, contained a surplus of the plus 8-mesh, plus 14-mesh, and minus 100-mesh sizes, and a deficiency in the plus 28-mesh, plus 48-mesh, and plus 100-mesh sizes. From this standpoint there was no choice between the machines; with any of them improvements in grading could be effected only by selective screening and recirculation of the undesired oversize for further grinding, and by a reduction in the amount of minus 100-mesh material by washing. However, when the grain shapes of the products of the different crushers were compared, marked differences were apparent. The hammermill product was cubical, that of the crushers contained some flats, and that of the crushing roll was composed of splinters. Tests by two methods indicated that about 5 per cent more cement was necessary to make the workability of a cone crusher sand (the next best) equal to that of a hammermill sand of identical grading. All experimental evidence pointed to the desirability of hammermill sand for use in concrete, and indicated that any additional cost of operating hammermills due to high metal wear would be less than the cost of the extra cement needed to overcome the effect of poor particle shape in the other sands.

The original installation consisted of two mills, 48 in. long by 42 in. in diameter, direct connected to 250-hp, 880-rpm motors. The rated capacity of each mill was 60 tons per hr of material passing a $^1/_4$-in. square opening. The feed to the mills, composed of material ranging in size from minus $^1/_4$ in. to 3 in. maximum, was regulated by electric vibrating feeders suspended beneath a storage bin. Two additional mills of the same size but of different make were later installed for use during repairs and to increase production. The product of the hammermills was conveyed to double-deck screens, the top deck having $^1/_4$-in. square openings and the lower deck 8-mesh openings. All material retained on the top deck was returned to the mill for further reduction, as was the surplus retained on the lower deck—that is, the plus 8 mesh minus $^1/_4$-in. material made in excess of proportioning requirements. For further flexibility in controlling the grading of the finished sand, the two fractions produced were stored and batched separately. Thus, the material passing the lower deck was washed to reduce the amount of minus 100-mesh material and handled as fine sand; and a selected quantity of the material retained on the lower deck was stored and batched separately as course sand.

Sieve analyses of the two sands produced were quite uniform. The average percentages by weight of the sizes produced below 4 mesh for the first five months of operation are given in Table I. The table also shows the grading of a combined sand obtained by blending about 21 per cent of coarse sand with 79 per cent of fine sand; this



PART OF GRAND COULEE DAM AGGREGATE PLANT, AFTER SEVERAL MONTHS OF OPERATION
The Screen House, Raw Storage Pile, Crusher House, and Wash Water Clarifier Tank Are Beyond the Limits of This View, to the Right of the Sand Classifier House



Mining Operations in Grand Coulee Dam Pit; 60-In. Conveyor to Plant in Foreground
The 42-In. Feeder Conveyors Were Extended as Shovels Progressed Into Gravel Bank

mixture is representative of the fine aggregate being used at the time.

It is to be noted that there was still a slight deficiency in the amount of sand between the 28-mesh and 100-mesh sizes. These sizes could not be produced in sufficient

Table I. Analyses of Fine and Course Sands from Norris Dam Hammermills

Mesh	Per Cent Retained: Fine	Coarse	Combined
4	0.0	0.0	0.0
8	2.8	80.5	16.4
14	31.3	14.9	28.0
28	26.3	1.2	19.8
48	15.9	0.5	12.7
100	10.7	0.5	9.7
−100	13.0	2.4	13.4

quantity at a reasonable cost, but the effects of this deficiency—poorer workability and some water gain—were minimized by the development of better mixes and the use of somewhat more of the minus 100-mesh material than first contemplated.

At the start sand production was low and metal wear high, and a large amount of experimental work was necessary to develop the desirable operating characteristics later found possible with this equipment. Cost of metal wear amounted to about 6 cents per ton of finished sand. About 16 per cent of the hammermill product was waste or minus 100-mesh material not needed in the fine sand. Final results were very satisfactory, and there is no doubt that the use of hammermill crushers was justified from the standpoint of quality as well as from the standpoint of cost.

ROD MILL PROVES EFFECTIVE AT MARSHALL FORD DAM

For processing the 500,000 tons of concrete sand used for the construction of the Marshall Ford Dam, a rod mill is employed to crush a sand that is too coarse for use in its natural state. Excellent results are being obtained with this installation—probably the first of its kind to be used for the purpose. The original plant was designed on the basis of mixing a fine with a coarse sand, separating the mixture at about the 14-mesh zone, and wasting such amounts of the coarser fraction as might be necessary to control the grading of the final product. However, the expense of procuring fine sand proved unwarranted and caused favorable consideration of the use of a rod mill for grinding the coarse sand that occurred with the gravel and of dispensing with the fine sand entirely. The two sand classifiers of the reciprocating rake type originally installed were suited perfectly to the operation of the rod mill. The first classifier, making the coarse separation, has a 6-ft rake width and a capacity of 120 tons per hr, while the second machine has an 8-ft rake width and a capacity of 70 tons per hr.

The sand and water passing the screens is fed to a conical tank with a peripheral overflow weir. Here surplus wash water is removed and the sand, with some water, is drawn from the bottom of the tank and flumed to the first classifier. The rake product of this machine, mostly coarse sand, is split by means of gates and sent in part to the rod mill, in part to waste, and in part to the stock pile conveyor. The overflow is flumed to the second classifier, which merely dewaters the finer sand and overflows the excess of the minus 100-mesh material. The product of the rod mill is flumed to and also dewatered in the second classifier, whose total rake product is dropped to the stock-pile conveyor. Thus the fine and coarse sands are placed on the belt in layers, but the subsequent handling and stock-piling thoroughly mix the two fractions, as is indicated by the consistent test results being obtained at the m.xing plant. Frequent testing of samples from this belt indicates any changes necessary in the amount of coarse sand being sent to the mill or wasted.

The type of mill purchased was recommended by the manufacturers as a result of laboratory tests made by them on a sample of the sand from the river bar. The mill is 5 ft in diameter by 10 ft long, and has a speed of 25 rpm, and a power of 100 hp. The charge consists of 43,000 lb of grinding rods, $2^1/_2$ and 3 in. in diameter, 10 ft long, which about half fill the mill. These rods are made of steel with a carbon content of about 1 per cent. The following typical analyses of the sand before and after passing through the mill show the extent of the reduction obtained:

Fineness Modulus	Per Cent Retained on Mesh Number: 4	8	14	28	48	100	−100
Before......3.51	1.3	19.0	35.4	26.1	11.9	4.2	2.1
After.......2.19	0.0	0.2	8.6	36.7	29.4	14.3	10.8

The product of the rod mill is an excellent blending sand, and when added in the right amount to the natural sand, produced concrete sand meeting specifications. The particle shape of the broken grains appears not to differ from that of the natural product. The combination of rod mill and classifiers is highly satisfactory and repre-

Screen Structure and Stock Piles at Marshall Ford Dam Plant
Plant Capacity Is 350 Tons per Hr

sents about the optimum in flexibility to meet the changing conditions of sand gradation as they occur in the pit. If a layer of fine sand is encountered, it is sent to the plant with the raw feed, and the rod mill may be shut down until the sand runs coarse again. Metal loss from rods has amounted to only about $^3/_4$ lb per ton of sand produced. The liner plates in the mill are expected to last the job. Feed to the mill varies from 30 to 70 tons per hr, best efficiencies being obtained at medium rates.

GRAND COULEE AGGREGATE PLANT LARGEST EVER BUILT

The Grand Coulee Dam aggregate plant, installed under the first contracts, is probably the largest in point of capacity that has ever been built to furnish material for a concrete dam. During the four months of peak concrete production—July through October 1937—the concrete placed averaged 350,000 cu yd per month, and during the maximum month some 396,000 cu yd were put in. However, the actual duty on the plant was about twice what these figures indicate because, owing to the excess quantity of sand in the pit, 2 cu yd of pit material were processed to produce material for 1 cu yd of concrete. During this four-month period the plant feed averaged 1,800 tons per hr and yielded 660 tons per hr of gravel, 240 of sand, and 900 of waste.

The sand and gravel deposit discovered about $1^1/_2$ miles from the dam site was of glacial origin, and lay about 1,000 ft higher than the river bed. Test pits, some of them 300 ft deep, indicated that the sand when mixed with gravel was predominantly coarse, but that the deposit was interspersed with lenses and layers of fine sand, and that sufficient sand of the proper grading could be obtained from that which normally would accompany the gravel.

The special conveying equipment designed for transporting the pit material to the plant is of interest. Self-propelled loading hoppers at the end of 200-ft conveyor booms followed the 5-yd shovels making radial cuts in the gravel bank. Each conveyor boom was pivoted on a special carriage, through which it transferred the material to a 42-in. lateral conveyor. The lateral conveyors in turn fed the 60-in. main collecting conveyor to the plant. The laterals were extended as the shovels progressed into the gravel bank. Three of these laterals were used at the peak of production and handled a total of some 2,000 tons per hr of pit material.

In fitting the plant to the topography, advantage was taken of the elevated location of the deposit to provide a storage pile for raw material ahead of the crushing unit and another following the crushers and ahead of the screens to provide for several hours' operation of these units in case of a shutdown for repairs. Pit material was put through two revolving screens preceding two gyratory crushers, which reduced all material to minus 6 in. Conveyors in twin recovery tunnels beneath the storage pile fed the two identical sections of the screening plant, either of which could be operated independently of the other. Four double-decked vibrating screens, 5 ft by 10 ft, separated the 6-in. from the 3-in. stone, while 8 double-decked screens of the same size were required for the $1^1/_2$-in. and $^3/_4$ in. sizes. Conveyors from the screen house filled the stock piles at the gravel plant from which the mixer storage was drawn.

Sand classifying equipment for handling some 1,500 tons per hr of sand would have represented quite an investment, and therefore facilities were installed for dewatering the sand ahead of the classifiers and wasting all sand not needed for classification purposes at that point. Eight drag-type dewaterers, each 10 ft wide, were put in for this purpose. In operation, it was found that a marked degree of hydraulic separation occurred in the drags themselves, because the water and sand from the screens was introduced at one side and allowed to flow across in a flume paralleling the position of the drag rakes. Numerous spigots opened from the flume into the drag tank. The coarser particles were discharged first, leaving the finer to be discharged from the spigots further along the flume. Advantage was taken of this separation by selecting the classifier feed from the fine or coarse ends of the rake discharge, as might be required.

The classifying equipment, consisting of three machines of the bowl-and-rake type, was able to handle 500 tons per hr of raw sand. A selected amount of raw sand from the drag dewaterers was conveyed to the first classifier, which took out the sand in the 4- to 28-mesh zone. All finer material overflowed to the second classifier, which retained material in the 28- to 48-mesh zone. The third classifier settled out material finer than 48 mesh, but overflowed and wasted material finer than 100 mesh in excess of requirements. The rake product of these classifiers could be wasted or conveyed to stock piles over a recovery tunnel where variable-speed feeders were employed for proportioning.

The disposal of 18 carloads of waste sand per hour at the peak of production was accomplished by means of a

DISCHARGE END OF A RECIPROCATING RAKE SAND CLASSIFIER

42-in. stacker conveyor mounted on self-propelled caterpillar treads. The stacker was pivoted at the receiving end and discharged in radial layers, advancing as the space became filled.

Additional information on the production and handling of aggregate at Grand Coulee is contained in an article by C. D. Riddle in CIVIL ENGINEERING for October 1936, "Construction Plant at Grand Coulee Dam."

The one factor contributing most to a low aggregate cost is the ability of a plant to produce continuously at a high rate. The use of good judgment in design, the selection of the proper machinery and plant operating personnel are very important, but once the plant is installed and in operation, production must be maintained if lowest costs are to be realized. The design capacity of an aggregate plant is usually geared to a concreting schedule, but almost without exception this schedule is exceeded and the aggregate plant as a consequence is overloaded. Immediately capacity limitations appear in some of the units and mechanical failures occur. Such experience points to the wisdom of selecting rugged, heavy-duty machinery of ample capacity and proved performance.

Automatic Design of Continuous Frames

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A CRITICISM of all methods of analysis of continuous framed structures is that the designer can seldom afford the time necessary for revising a preliminary design to agree with theoretical analysis. The basis for such criticism is that a tedious process of repeated analysis has been the only method available for the design of a continuous frame. The design process presented here takes the individual procedures required in older methods and welds them together into a single series of successive corrections, not unlike the Cross method of moment distribution, that approaches a purely automatic method of design. The advantages are an important saving of time, a fortunate simplicity that permits the experienced designer to advance the convergence by use of his judgment, and an automatic feature that results in good design irrespective of the inexperienced designer's initial errors of judgment.

THE fundamental conception of automatic design is that section moduli for special cases can be balanced just as moments are balanced, since

$$\text{Section Modulus} = \frac{\text{Bending Moment}}{\text{Working Stress}}$$

Manifestly the limitations to be set, in order to permit this simple procedure, are (1) that all members must have the same working stress, and (2) that there can be no joint translations. Both of these limitations will be removed later.

Nomenclature. The same terminology will be used as in balancing moments:

F.E.M., B.M., and C.O.M.	=	fixed-end, balancing, and carry-over moduli
C.M.	=	correction modulus, of special significance in automatic design
L, I, b, d, c	=	length, moment of inertia, breadth, depth, and extreme fiber distance of a beam
L/d	=	prismatic ratio for a uniform depth
I/c	=	section modulus, also called S
I/L	=	stiffness ratio, also called K
f	=	allowable fiber stress

Sign Convention. A positive moment is one which tends to rotate the adjacent joint clockwise. Based upon this convention, a horizontal beam subjected to downward loads has a positive fixed-end modulus at the left and a negative fixed-end modulus at the right. The carry-over factor is $+0.5$ for a prismatic beam, which means that the carry-over modulus is of the same sign as the balancing modulus that produced it. Balancing moduli are of opposite sign to the unbalanced joint modulus. The balanced moduli at a joint in equilibrium add up algebraically to zero.

BALANCING SECTION MODULI

The Procedure. If the limitations of no joint translations and a constant working stress are temporarily accepted as a starting point, then the stiffness factor, or relative I/L value, becomes the section modulus divided by the prismatic ratio, L/d, thus

$$\text{Relative } I/L \text{ value} = \frac{I}{c} \div \frac{L}{d} \quad \ldots\ldots [1]$$

Hence the procedure is first to divide all fixed-end moments due to the applied loads by the constant working stress to obtain the fixed-end moduli. Then a division of the larger fixed-end modulus in each span by a guessed-at prismatic ratio (L/d) for the corresponding span gives relative I/L values for modulus distribution around the joints. The fixed-end moduli are then balanced once or possibly twice, and the maximum modulus for the span is used to choose a reasonable depth for the section. The balanced modulus divided by the revised L/d ratio gives rise to a new relative I/L value for modulus distribution.

Correction Moduli. A percentage increase or decrease in I/L of one member necessitates a corresponding percentage change in moduli introduced to account for joint rotation, that is, in the sum of all balancing moduli and carry-over moduli at the ends of this member. This introduces a correction modulus that must then be balanced itself. Fixed-end moduli are caused only by the loads and are not changed by a revision of an I/L value. After the introduction of the first correction moduli, the process is to be continued until a natural convergence is reached. Correction moduli will need to be introduced two or possibly three times for a typical design problem.

Instructions for Balancing Moduli. The process of balancing section moduli can be set up as a series of outlined steps, which can be revised as desired to permit the experienced designer to speed the series convergence.

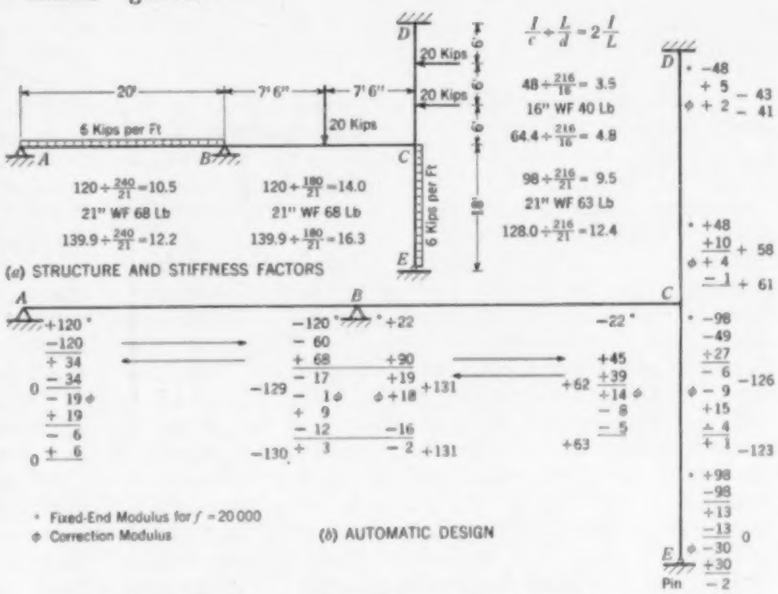

Fig. 1. Design of a Frame Without Sidesway

PRELIMINARY STEPS:

(a) Divide fixed-end moments by the constant working stress to obtain fixed-end moduli.

(b) Guess at, or otherwise select, preliminary L/d ratios for each span.

(c) Divide maximum fixed-end moduli or I/c values by corresponding L/d ratios to obtain preliminary stiffness factors or relative I/L values.

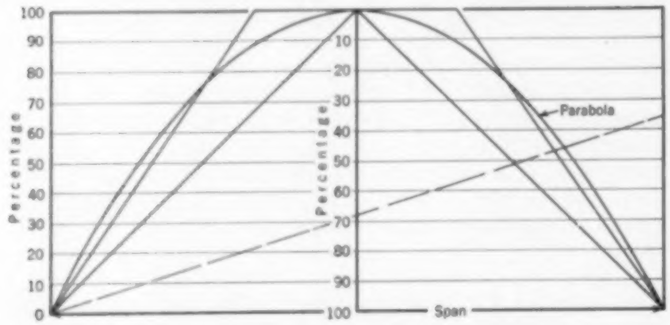

FIG 2. DETERMINATION OF THE CONTROLLING MODULUS NEAR CENTER OF A SPAN

REPEATING STEPS:

1. Balance moduli once (or twice) at each joint by use of distribution factors computed as $K/\Sigma K$ where $K = I/L$. Draw a line under each balancing modulus and do not rebalance any figure above this line.
2. Sum section moduli and use the maximum modulus in each span to choose a satisfactory approximate depth of cross-section (d) which gives rise to a new L/d ratio.
3. Divide the improved modulus by the new L/d ratio to obtain a revised relative I/L value in each span.
4. For each column of moduli, compute the increase or decrease in the sum of all balancing moduli and carry-over moduli (but not fixed-end modulus) by using the percentage increase or decrease in the corresponding I/L value. This unbalanced modulus should then be introduced as a correction term to be balanced later.
5. Repeat Steps 1, 2, 3, and 4 once or twice until a satisfactory convergence is reached.

Two procedures clearly become possible in Step 3.

(a) The controlling balanced modulus obtained as a column summation might be used as I/c, which is then divided by L/d to obtain a relative value of I/L, or

(b) The actual modulus taken from the handbook for the section chosen in revising L/d can be used as I/c, which is then divided by L/d to obtain the relative value of I/L.

The first procedure (a) is the natural one for the designer to follow, particularly in the initial stages of automatic design, but procedure (b) should be introduced in preference to (a) in the latter stages of the process. Certainly for accuracy the final value of I/L should be obtained from the handbook modulus.

Example of Balancing Moduli for a Continuous Steel Frame Without Sidesway. The arrangement of computations in Fig. 1 (b) was chosen to make the example as nearly self-explanatory as possible. The fixed-end moments are divided by a working stress of 20,000 lb per sq in. to obtain fixed-end moduli, which are marked with an asterisk. A table of the properties of beam sections is then used to select reasonable depths of beams that will furnish moduli as great as the largest fixed-end modulus in each member. Since in balancing moduli there will be equal, final moduli on the two sides of the first interior support B, the second span, BC, was chosen of the same depth as the first span, AB. Direct stress is not considered in this example.

The initial stiffness factor or relative I/L value for each member was obtained as the maximum fixed-end modulus divided by the prismatic ratio L/d. Thus in the span AB we obtain $120 \div (240/21) = 10.5$, or in the second span, $120 \div (180/21) = 14.0$ (Fig. 1a). The corresponding stiffness factors for the vertical members are 3.5 and 9.5. By use of these relative I/L values as stiffness factors, the section moduli are balanced once or twice at each joint. In Fig. 1 (b) the sequence for balancing joints was A, B, A, E, C, E; however, any other sequence would be satisfactory. The fixed joint D naturally is not to be balanced. After the balance of each joint once or perhaps twice, it will be proper to total the moduli in each column of figures and to record the result beside the column as in Fig. 1(b). The figure of -129 beside the second column of figures, on the left side of the joint B, is such a total. The use of a table of beam properties makes it a simple matter to choose sections so that each span will resist the maximum balanced modulus of that span. The choices made are 21WF68 for AB and BC, 16WF40 for CD, and 21WF63 for CE. Then the modulus of each section is divided by the revised L/d ratio to give the new relative I/L value. In Fig. 1 (a) no revisions of d or of L/d were found to be necessary.

Introduction of Correction Moduli. When an I/L value is changed as just described, it becomes necessary to increase or decrease the corresponding balancing moduli and carry-over moduli for this span in the same proportion as the change in I/L. Thus in span AB of Fig. 1 (a), the increase of I/L from 10.5 to 12.2 necessitates a 16 per cent increase in the change of -120 from the fixed-end modulus at the joint A. The correction modulus is therefore -19. At C of the member CE the modulus change is from -98 to -126, an increase of -28. The stiffness factor is increased from 9.5 to 12.4, or 31 per cent. Accordingly, the correction modulus at C for this member is $0.31 \times (-28) = -9$. Finally, correction moduli are balanced along with other remaining unbalanced moduli and new summations of columns of moduli are obtained. It is found that the sections chosen are satisfactory for these final moduli requirements. If any section had been found inadequate or of excessive strength, we could revise our choice, recompute L/d and I/L, introduce correction moduli for this span, and rebalance. This process is to be repeated to convergence, which usually requires the introduction of two sets of correction moduli.

The final sections that are indicated in Fig. 1 are 21WF68 for AB and BC, 21WF63 for CE, and 16WF40 for CD. These sections represent such a minor change from the moduli requirements of the final balancing of moduli that an attempt to reduce the weight of any member would be futile. Depths could of course be reduced at the expense of added weight.

Required Modulus near the Center of a Span. It will be found that the section evolved for the span AB in Fig. 1 (a) was controlled by the maximum end modulus but the required modulus near the center of its span was nearly as great. In order to make the selection rapidly where mid-span requirements may control, a graph such as Fig. 2 is necessary. The use of Fig. 2 is as follows: Express the end moduli as percentages of the simple-beam modulus and draw a line across the chart connecting these two end values, such as the broken line from zero at the left to 64 per cent at the right. By inspection it is seen that the maximum modulus requirement near the center would then be 69 per cent of the simple-beam modulus as required by a uniform load. If this had been the situation in span AB of Fig. 1, the mid-

span modulus requirement would have been 0.69 × 180 = 124. Actually the end modulus of 130 controlled.

ECONOMY IN DESIGN

Steel Beam Sections. Economy can be achieved in steel beam selection by the use of a table of section moduli arranged in order of weight for a gradually increasing modulus. Such tables are available in the structural handbooks. (See *Steel Construction*, American Institute of Steel Construction, 1937, pages 90–97.) It is possible by use of these tables during the automatic design process either to choose sections economically or to choose uneconomical shallow sections with complete realization of the waste involved. The control of economy in the automatic design process is centered in the choice of the prismatic ratio L/d. For instance, 18-in. WF beams are economical for moduli from 73.7 to 98.2 in.^{3} The 21-in. sections become economical from 99.7 to 150.7 in.^{3}, while the 18-in. sections drop to second choice and then to third or fourth choice for economy.

Design for Shear or Reaction. It is possible to take shear into consideration when selecting a beam, although in most cases shear does not control the design of continuous frames. Shear is not critical in the structures used for illustration here. The initial procedure might be to estimate the shear as that existing in a simple span and to select a beam with an adequate web. Then, if this section was more than adequate to furnish the required modulus, the handbook modulus (S) would be used for computation of the relative value of I/L as $S \div L/d$. For the unusual case where shear is very important, an actual calculation of reactions and shears from moments, as given by the balanced moduli near the end of the convergence, would be in order.

DESIGN FOR SIDESWAY

The Problem. Sidesway or side lurch occurs in bents and in similar frames subjected to lateral loading and even in such structures when they are subjected to vertical loading provided that either the structure or the loading is unsymmetrical. Continuous beams, and frames not subject to sidesway, can be designed by balancing section moduli as in Fig. 1. Bents and frames subject to sidesway will be designed by the automatic process when modified to permit a shear balance as one of the steps of successive corrections.

Procedure for Balancing Shears. A bent loaded with vertical and lateral distributed loadings, Fig. 3, will be used to illustrate the automatic method of design. Intra-panel loads give rise to fixed-end moduli which are balanced in the usual manner. The algebraic sum of the balanced moduli at the two ends of a column may be divided by the column length and multiplied by the working stress to give the column shear. This shear becomes the change from the fixed-end shear, if intra-panel lateral loads exist, and if the end moduli used in the shear computation represent the change from the original fixed-end moduli which were required by the intra-panel loads.

After the shears have been computed in each column, the computation of the unbalanced horizontal shear is merely an application of the equation of statics, $\Sigma H = 0$. This unbalanced shear is then balanced by an equal and opposite shear which is divided between the columns in proportion to their I/L^2 values. From the correction shear to be introduced into the column, correction moduli are computed as the shear multiplied by one-half of the column length and divided by the working stress. Such correction moduli are balanced in the usual manner. This procedure is followed in Fig. 3.

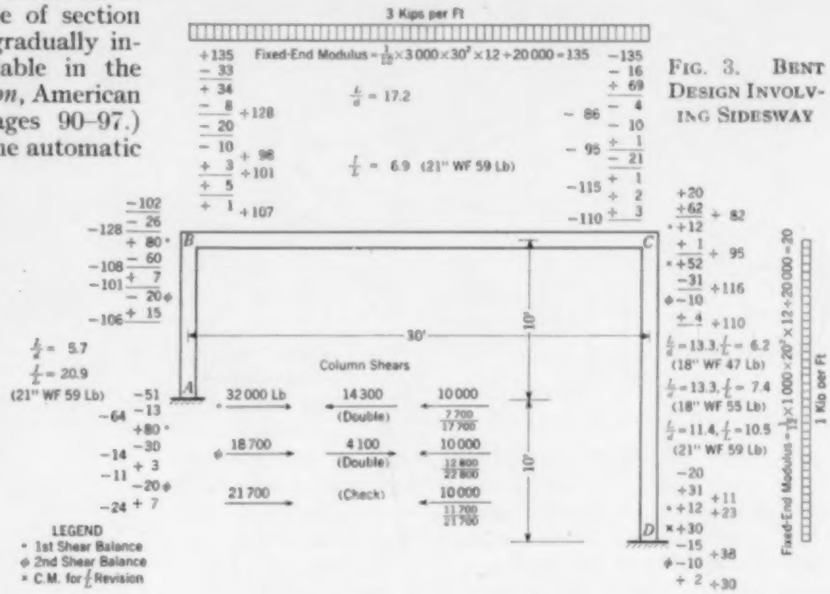

FIG. 3. BENT DESIGN INVOLVING SIDESWAY

With experience, the designer will learn to compute correction moduli for balancing shears without an actual determination of the column shears or of the unbalanced shears at all. In fact, an experienced designer will use his judgment for introducing an excess of fixed-end modulus, so that, upon balancing, the loss of modulus will compensate for the introduction of excess modulus and the result will be a more perfect shear balance. In Fig. 3 such fixed-end moduli for shear balance were doubled to speed the series convergence.

Example of an Unsymmetrical Bent. An unsymmetrical bent with vertical and lateral distributed loadings is designed in Fig. 3. Oddly, the members finally selected are identical for columns and girder, although this does not simplify the design particularly. Side lurch is an important factor in this design. The design procedure in outline is as follows:

1. Fixed-end moduli of 135 in the girder and 20 in the right-hand column are obtained from the fixed-end moments for a working stress of 20,000 lb per sq in.

2. Moduli requirements are estimated crudely as 100 at the joint B and 80 at the joint C. The left-hand column and the girder are therefore chosen as 21WF59 sections, and the right-hand column is chosen as an 18WF47 section.

3. Fixed-end moduli are balanced twice at B and once at C. The moduli summations then become 64, 128, 82, and 11 at A, B, C, and D, respectively.

4. Column shears at the girder level are computed from these balanced moduli and found to be 32,000 lb in the left-hand column and 17,700 lb in the right-hand column. The difference of 14,300 lb, doubled to prevent loss in balancing, is divided between columns and used to compute the column moduli of 80 and 12 that are marked with an asterisk.

5. After being balanced, the column moduli are summed again to obtain the critical values of 108 and 95 at B and C. The modulus of 95 at C would require an increase of column section to an 18WF55 beam. The increase of I/L value from 6.2 to 7.4 would necessitate an increase of column modulus of $(1.2 \div 6.2)\ (95 - 20)$

= 15. Even after balancing, the result obviously would be to increase the modulus requirement beyond (98.2) that of an economical 18-in. section; hence, a 21WF59 section is tried. The new L/d value is 11.4 and the new I/L value is 10.5. This change results in the introduction of correction column moduli of +52 at C and +30 at D which are to be balanced.

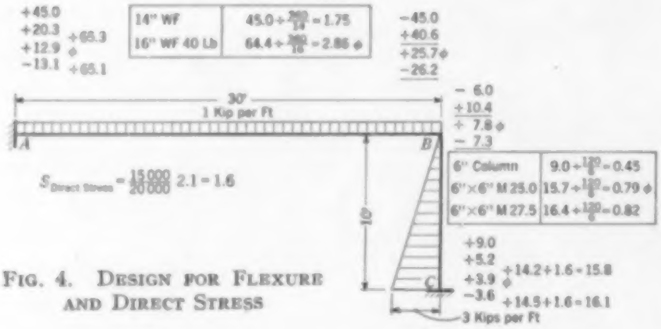

FIG. 4. DESIGN FOR FLEXURE AND DIRECT STRESS

6. The balance of these column moduli gives rise to total moduli of 11, 101, 116, and 38 at the joints A, B, C, and D. The corresponding shears are 18,700 lb and 22,800 lb. A correction shear of 4,100 lb acting to the right is doubled to prevent loss on balancing and introduced to give rise to fixed-end column moduli of 20 in the column AB and 10 in the column CD. These moduli are balanced and final moduli are found to give rise to balanced shears of 21,700 lb in each column. Moduli requirements for columns and girder are within the economic limits for the sections chosen. Moduli requirements near the ends rather than near the centers of the spans control all members. The design is therefore completed, and it is the most economical design obtainable.

DESIGN FOR COLUMN DIRECT STRESS

Effect of Direct Stress on Design. Direct stress is of sufficient importance to increase column sections as required by the modulus determination of Fig. 3. For instance, the direct column stress for either column of Fig. 3 would be roughly $(3{,}000 \times 15) \div 17.4 = 2{,}600$ lb per sq in., an increase in working stress of 13 per cent. This influence can be introduced readily into the design when the direct load on the column remains essentially constant; otherwise the procedure requires repeated computation of this load after successive steps in the design convergence.

Direct Stress and Moment Relationship. A simple relationship long understood exists between direct fiber stress and flexural fiber stress. Since $P/A = Mc/I = M/S$, then

$$M = P\left(\frac{S}{A}\right) \qquad [2]$$

By dividing each side of the equation by the working stress, f, we obtain the section modulus,

$$S = \frac{P}{f}\left(\frac{S}{A}\right) \qquad [3]$$

Fortunately for the use of this relationship in automatic design, the factor S/A is quite constant for beam sections of a given depth as shown by Table 1.

As soon as the balancing of moduli has been carried far enough to select a section that is more than a crude guess, the factor S/A becomes nearly a constant, and of course P/f is a constant except for changes in P that may accompany the balancing process. Hence the modulus to be added for direct stress can be computed from the relationship of Eq. 3 with reasonable certainty that revisions of this quantity will be comparatively small. This direct-stress modulus is to be looked upon as an increment of the modulus required by flexure. If it necessitates an increase of I/L, or a change of L/d and therefore of I/L, it thereby necessitates a proportionate increase in all balancing moduli and carry-over moduli, but it is not in itself to be balanced or otherwise introduced into the balancing process. For this reason the introduction of this modulus is a particularly simple and convenient way of designing a structure to resist direct stress as well as flexure.

TABLE I. VALUES OF S/A FOR STEEL BEAM SECTIONS

Section	S	A	S/A	Section	S	A	S/A
21 WF 59	119.3	17.36	7.02	21 WF 82	168.0	24.10	6.97
63	128.0	18.52	6.98	89	182.8	26.15	6.99
68	139.9	20.02	6.92	96	197.6	28.21	7.00
73	150.7	21.46	6.88	103	213.1	30.27	7.0[illegible]

Example of Design for Combined Stress. The example of Fig. 4 illustrates the introduction of moduli to care for direct stress in a column. The fixed-end moduli are balanced once at B and carried over to A and C, distribution factors having been computed for depth estimates of 14 in. for the girder and 6 in. for the column. The controlling modulus for the column then becomes 14.2, which is in the range of the miscellaneous 6-in. light column group designated in the American Institute of Steel Construction handbook by the symbol M. For this group of sections the value of S/A is about 2.1 and

$$S_{\text{direct stress}} = \frac{P}{f}\left(\frac{S}{A}\right) = \frac{15{,}000}{20{,}000}\,2.1 = 1.6 \quad \ldots [4]$$

The total modulus requirement for the column therefore becomes $14.2 + 1.6 = 15.8$, which is furnished by a 6×6M25 section. Correction moduli are introduced to account for the increased stiffness of the column and also for the beam which has been changed to a 16WF40 section. After moduli are again balanced, the requirement for the column becomes 14.5, which is increased by 1.6 to account for direct stress. The total is 16.1, which requires an increase to the 6×6M27.5 section. The beam is still found satisfactory, and therefore the minor change in the column section would have a negligible effect upon moduli requirements. Also the reduction of column load below 15,000 lb, which could be shown to occur, is considered sufficiently unimportant to neglect in this instance. Hence correction moduli are not introduced, but, instead, the 16WF40 and 6×6M27.5 sections are accepted as final.

Variations of Working Stress. There may be some question as to the use of a working stress of 20,000 lb per sq in. for the column of Fig. 4. Actually, the fiber stress in this member is nearly 90 per cent from beam flexure, but a reduced working stress dependent upon slenderness ratio can properly be introduced into Eq. 4 whenever column action is important. For such cases it is also necessary to reduce the working stress for flexure because the lateral deflection caused by flexure makes the direct load on the column eccentric. There is no difficulty involved in changing a working stress for any individual member. If the working stress is to be reduced 25 per cent, for example, we merely increase the balanced modulus by 33 per cent when it is being used to compute stiffness, as $I/c \div L/d$, or when a section is being chosen from the handbook.

The Sardis Dam and Reservoir

Design Features of $15,000,000 Flood Control Project in Northwestern Mississippi

By NORMAN R. MOORE, M. AM. SOC. C.E.

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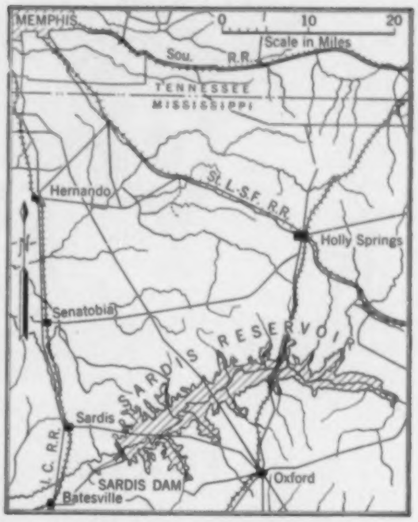


FIG. 1. LOCATION MAP

THE flood problem in the Yazoo River basin results from the fact that the main tributaries draining the hill section, which comprises the northeastern half of the drainage area, collect and discharge runoff at a greater rate than the slow-moving streams in the lowlands can carry it off. The Sardis Reservoir (Fig. 1), by impounding the flood flows of the Little Tallahatchie River, will control flow from 1,545 sq miles of hill area—23 per cent of the total hill area contributing to headwater floods above Yazoo City.

The general configuration and the soil types of the Little Tallahatchie watershed, together with other features such as the shape of the drainage area, the high percentage of cleared land, and the existence of drainage ditches, are conducive to a high runoff factor. The mean annual precipitation over the watershed, based on records from 1897 to date, is about 51 in., and the maximum of record is about 70 in. A considerable proportion, perhaps as much as 75 per cent, usually falls in the period from December through May. The most satisfactory records of stream flow below the dam site are from a gage at which the drainage area is about 105 sq miles greater than that at the site. These records, extending from 1928 to date, show a maximum instantaneous discharge of 65,000 cu ft per sec, and a minimum flow of 255 cu ft per sec.

The reservoir is designed on the principle that the capacity should be sufficient for complete control, at the dam site, of tributary inflow from the maximum storm series of record, and that the maximum outflow, when combined with the runoff from the uncontrolled area below the dam, must not exceed the capacities of the channels as improved under the comprehensive plan. Owing to the relatively small channel capacities in the Mississippi alluvial plain, and also to the even distribution of rainfall in winter and spring and the long period of runoff concentration, it will be necessary to hold reservoir outflows to a minimum during the winter and spring months. An extended study was made of the storm series of record for the Yazoo River basin, involving finally the construction of hypothetical storage hydrographs. The routing computations contemplated restriction of reservoir outflows to a maximum of 3,400 cu ft per sec during the flood season, with increase during the emptying period to a maximum of 7,500 cu ft per sec in order to insure that the reservoir would normally be emptied prior to the following flood season. The storage hydrographs showed that a maximum pool elevation of 281.7 ft would have been attained as a result of the storm series of 1932. Accordingly, El. 282.0 was selected as the elevation of the spillway crest. The total reservoir capacity to this elevation is 1,570,000 acre-ft, of which 1,478,000 will be available for flood control storage and 92,000 will be permanent storage maintained for incidental recreation purposes, a minimum pool elevation of 235.0 ft having been arbitrarily selected with that object in view. Flood control capacity is thus equivalent to a runoff of 18 in. from the drainage area of 1,545 sq miles.

THE Sardis Reservoir is the first unit to be authorized in a comprehensive plan for the control of floods in the Yazoo River basin, in northwestern Mississippi. The dam was put under construction in 1936, and is scheduled to be completed in 1940. In the present article Mr. Moore discusses the design of the project from the standpoint of hydrologic, hydraulic, and structural requirements. The author's explanations of the basic design assumptions, and his frequent references to alternative designs that were tried and found wanting, make his paper of special interest and value.

Having established the spillway crest elevation and the hydraulic requirements of the outlet structures, the next step was to determine the spillway capacity. The flood hydrograph was constructed after a study of major storms within a radius of several hundred miles. The storm selected for use in constructing the hydrograph is the greatest of record in the South Central States, and occurred near Elba, Ala., March 12–15, 1929. It had a maximum intensity of 20.0 in. in 24 hours and a total rainfall of 29.6 in. in four days. It was transposed over the Little Tallahatchie River basin above the dam site without rotation of the axis, but so placed as to give the maximum precipitation over the basin. Air-mass analysis by the Norwegian method supported the conclusion that such a storm might occur in this locality. The estimated maximum probable inflow from this precipitation is 193,600 cu ft per sec. The computed inflows thus established were increased 50 per cent to provide a factor of safety.

It was assumed in spillway design that the reservoir pool would be at the spillway crest elevation when the maximum storms occurred, and as an additional precaution, that reservoir outflow would be completely stopped. The adopted criterion for the spillway required that sufficient capacity be provided to maintain the calculated freeboard from maximum pool elevation to top of dam.

A freeboard of 10.5 ft was adopted, taking into consideration the wave heights that would result from a persistent wind of high velocity. The establishment of spillway dimensions was then a matter of economics, to be worked out by balancing the cost of spillways of various capacities against the cost of the corresponding dam structure. The final design placed the top of the dam at El. 312.0, thus allowing about 19.5 ft of surcharged storage between the spillway crest and the freeboard limits.

A plan of the dam is shown in Fig. 2. At the site, the flood plain is approximately 7,500 ft in width and varies in elevation from 210 to 230 ft. Both abutments are formed by narrow ridges projecting from the upland and composed of hills and saddles ranging in elevation from 250 to 340 ft and more.

A comprehensive program of borings was carried out in the foundation and borrow areas. The borings

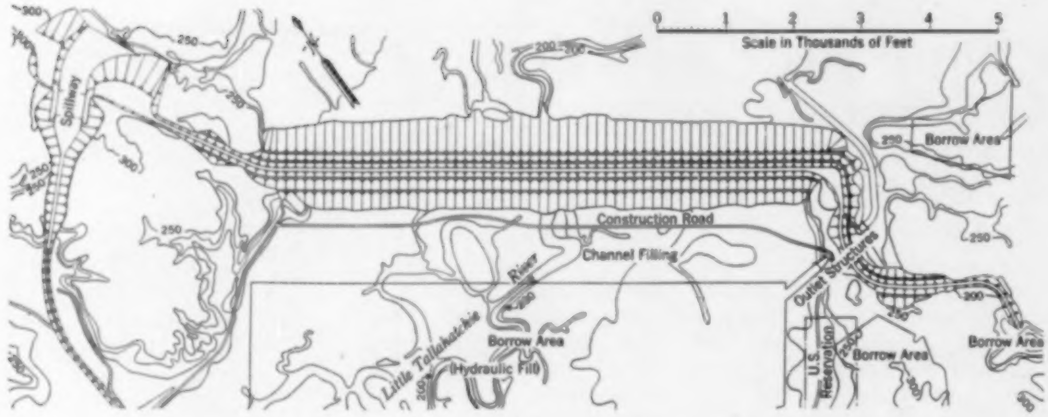


FIG. 2. GENERAL PLAN OF SARDIS DAM

were carried as deep as possible with an auger. When water was encountered, the bailer method of drilling was used and samples were taken by drive tube. The valley borings revealed a relatively impervious top stratum varying in thickness from 5 to 20 ft, consisting of silty and clayey materials; and the abutments were found to be covered with a thin blanket of loess. These surface materials are underlain to a depth of several hundred feet by variegated sands, with alternating layers of lignitic clay and sand in the upper part.

Samples of each class of material were subjected to laboratory examination and ample material suitable for construction of an earth dam was found in the valley. A limited supply was also found in the uplands in the vicinity of the abutments. However, the width of the valley and the relatively small difference in elevation between the uplands and the valley floor made it impracticable to sluice materials from hill borrow areas into the dam section. On the other hand, the valley material had such a high water content that it could not be economically used for rolled-fill construction. The thickness of the valley top stratum warranted the conclusion that a proper mixture of sand and fines could be obtained for core and shell construction at reasonable dredging depths, and therefore it was decided to construct the main structure by the full hydraulic method.

DESIGN OF EMBANKMENT SECTION

The first step in the design of the dam cross-section was the selection of an empirical design for preliminary study. This section was analyzed by the Swedish theory for stability against sliding in the shell, and by the Gilboy method for stability of the shell against blowout from a liquid core. Analytical methods were also used to determine the stability of the structure with respect to sliding, both on top of the foundation and on top of the lignitic clay strata in the foundation, and with respect to failure due to lateral flow of the top strata and of the lignitic clay. Models of this design section and of other proposed sections were constructed in a flume in the laboratory to investigate the hydraulic gradients throughout the section and the foundation and the effect of the proposed downstream toe drainage system on uplift pressures and escape gradient. The models were also used to estimate the total quantity of seepage, and to study the design of the upstream blanket and the position of the borrow pit below the dam.

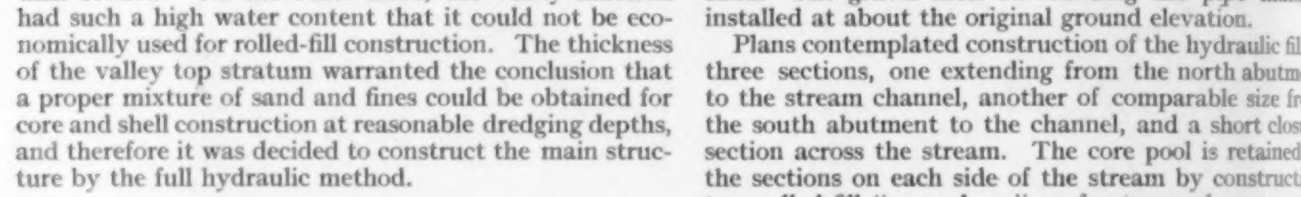
In Fig. 3 is shown the section finally adopted for the hydraulic fill. The flat upstream slope below El. 247.5 is not needed for stability but was introduced to save the cost of riprap protection that would otherwise have been necessary. Included in the section is an impervious blanket extending upstream from the core to 1,000 ft above the upstream toe, and having a minimum thickness of 10 ft at the toe and 2.5 ft at the upper limits. The blanket is composed of undisturbed natural material augmented where necessary by rolled fill. Because of the high cost of rock and gravel at the site, the conventional toe drain design—an inverted rock and gravel filter—is superseded by a pipe drain surrounded by a gravel filter. The system includes a perforated, bitumen-coated, corrugated metal pipe main, placed well inside the downstream toe and tapped at 400-ft intervals by laterals designed to conduct the seepage to an open ditch at the downstream toe. To increase the effectiveness of the drainage system, provision was made in the design for stripping the top stratum from about 60 per cent of the width of the downstream shell, and for replacing this impervious material with dredged sand. The gravel filter surrounding the pipe main is installed at about the original ground elevation.

Plans contemplated construction of the hydraulic fill in three sections, one extending from the north abutment to the stream channel, another of comparable size from the south abutment to the channel, and a short closure section across the stream. The core pool is retained in the sections on each side of the stream by constructing two rolled-fill "core plugs," or frustums of a pyramid, to be carried up well in advance of the hydraulic fill and to be incorporated permanently in the structure.

Dikes of rolled fill join the hydraulic fill to the abutment uplands. Other rolled-fill construction included a coffer-dike from each core plug upstream to the blanket limits, to form a part of the cofferdam required to permit unwatering of the stream channel preparatory to cleaning and blanketing in the closure section. Except for its high water content, most of the top stratum material stripped off was suitable for use in these coffer-dikes, and also in the core plugs and for patching the natural blanket. The plans provide that the hydraulic-fill core shall be carried to a point 10 ft below the top of the dam and that the remaining section shall be rolled fill.

The importance of adequately protecting the upstream slopes is evident when it is noted that the reservoir pool will have a fetch of more than 20 miles. Consideration

FIG. 3. TYPICAL SECTION OF MAIN DAM



was given to all practicable types of protection, and the selection was finally limited to a choice between 18 in. of hand-placed riprap, 36 in. of dumped riprap, and 24 in. of concrete tetrahedrons, each type to be backed with a 12-in. blanket of gravel. In order to investigate the effects of wave action on each of these types, a bank was graded to the slope of the upper portion of the dam, and test areas using each type were constructed. Arrangements were made to produce, as nearly as possible, waves of the same height and period as are estimated to reach the face of the dam. The dumped riprap proved to be definitely superior to the other types, and will accordingly be provided for the main dam. No deposits of rock are found in proximity to the site, and the rock to be furnished will be a dense, crystalline limestone to be quarried in Alabama. The riprap will consist of well-graded material, the greater part of which will weigh between 50 and 3,000 lb per piece.

The downstream slopes will be dressed with top soil and sodded. A slope drainage system will be provided to intercept surface water at the berms in paved gutters and to convey it through buried pipe laterals to the toe.

GATES NECESSARY TO MEET OUTLET REQUIREMENTS

The reservoir outlet is required to control the discharge from the reservoir during the high-water season and to empty the flood control pool in the succeeding low-water season. The type of outlet structure selected (Fig. 4) is a single conduit controlled by four gated intakes. During periods of restricted outflow, the discharge can be regulated by leaving one inside gate fully open. During the emptying period, the outflow can be adjusted by means of gate manipulation to the maximum channel capacity immediately below the dam (7,500 cu ft per sec). The outlet as designed is capable of maintaining this discharge for the pool range of El. 282.0 to about El. 261.

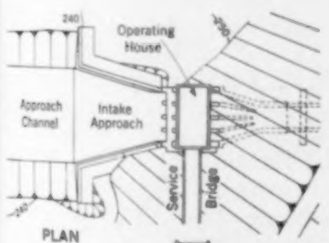
As indicated by Fig. 2, the outlet passes through the south abutment ridge, and discharge will reach the outlet channel about 1,000 ft below the toe of the main dam. The foundation materials here were found to be much the same as under the main dam. Beneath the surface layer of silt loam and silty clay loam is a layer of sandy material, which is underlaid by alternating layers of lignitic clay and sand. Explorations carried to El. 95 disclosed that the material from that elevation to El. 167 consists of fine and medium sand. Steel bearing piles were chosen for the support of the intake structure on account of the difficulty of driving timber piles of the required length (approximately 55 ft). A 10-in. 49-lb H-pile was found to support an ultimate load of more than 100 tons when driven to a penetration of 60 ft, measured from the natural ground surface approximately 33 ft above the intake footing. Timber piles were used to support the gravity-type walls of the intake approach and stilling basin structures, and, largely for purposes of anchorage, to support the stilling basin floor slab.

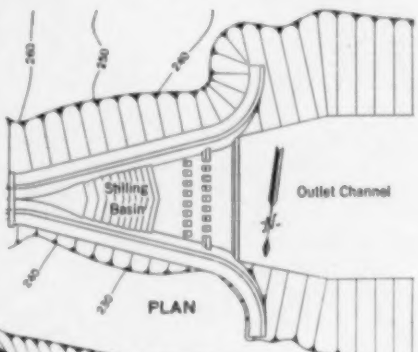
The cross-section selected for the conduit has a modified inverted egg shape 18.25 ft in height, which fulfills the hydraulic requirements and was found to be the most efficient structurally. The conduit was designed as a full elastic ring on a yielding foundation, and the transition structure was designed as a rigid frame.

The total gate area was made 25 per cent greater than the conduit area in order that, should one gate become immovable or obstructed by debris, the remaining gate openings would have sufficient capacity to insure completion of the emptying cycle within the allotted period. Caterpillar gates 6 ft wide and 12 ft high were selected. They will be operated by cable drum hoists located in the operating house. A single emergency gate, of the same design, will be operated by an overhead traveling crane to serve any of the service or emergency gate openings.

For the purpose of examining the hydraulic performance of the outlet structures, models of the preliminary and final designs were tested at the U. S. Waterways Experiment Station, Vicksburg. These studies established the adequacy of the original design but suggested certain modifications to improve the safety, economy, and efficiency of the completed work. For instance, the stilling basin wing walls, when placed at right angles to the center line of the structure as proposed in the preliminary design, were found to cause the formation of large eddies which produced a tendency to scour at the extremities of the end sill. The curved wing walls shown in Fig. 4 were adopted when it was demonstrated that they greatly reduced the intensity of these eddies, and virtually eliminated the tendency to scour. Air vents located along the crest of the conduit relieved the partial vacuum found to exist near the lower end, but caused that end to flow less than full for all discharges. It was concluded that the disadvantages of such vents outweighed their advantages. Individual risers for the vents placed back of the gates were adopted when tests disclosed that pressure differentials back of the gates set up flow through the common header originally contemplated.

Preliminary studies showed that the spillway could be located in either the north or the south abutment. The latter location suggested a structure, perhaps of the hollow buttressed dam type, combining both spillway and outlet, an arrangement not well suited to the north abutment. Such a structure was entirely feasible from an engineering point of view, and the plan was abandoned primarily to avoid a delay to the hydraulic-fill program. The determination to provide separate structures for the two outlet functions led to a decision to locate the structures in separate abutments.





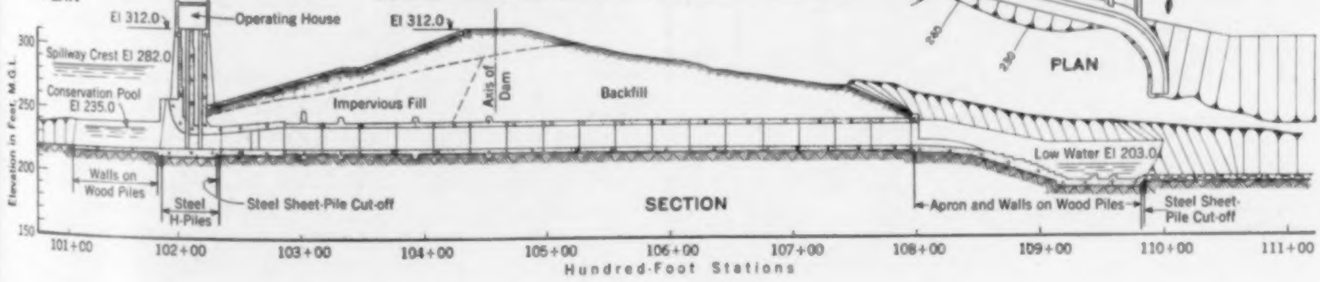


FIG. 4. PROFILE AND PLAN OF OUTLET WORKS

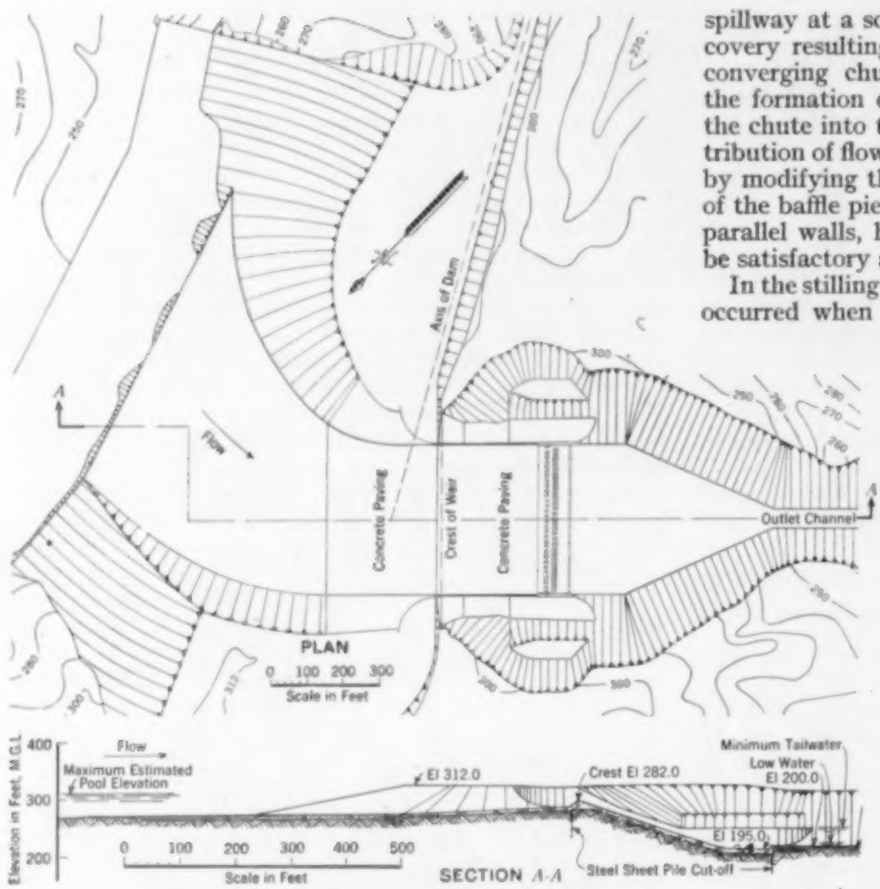


FIG. 5. PROFILE AND PLAN OF SPILLWAY

Accordingly, a favorable spillway site was selected about half a mile north of the northern terminus of the hydraulic fill.

Before the final design was adopted, numerous other arrangements were examined in considerable detail. In particular, a great deal of study was given to the possibility of utilizing two spillway structures—one a service structure of relatively short length with crest at or near El. 282.0, and the other an emergency structure of much greater length, with crest at such elevation that it would come into action only if the design assumptions as to runoff and reservoir inflow were actually experienced or exceeded. However, such an arrangement was found to be uneconomical under the conditions imposed by the site. Study was also given to gated crests; however, the conservative hydrologic assumptions, the proposed operating scheme, the great surcharge storage capacity available above the selected crest elevation, and other factors, led to the conclusion that in this installation gates are both unnecessary and undesirable.

As indicated by Fig. 5, the spillway as finally designed is of the open-channel type and consists of an approach channel with flared bottom and warped sides; a low, round-crested weir; a relatively steep paved chute with a bottom width of 400 ft and practically vertical side walls terminating in a bucket of the drop type; a concrete lined stilling basin; a short riprapped outlet channel; and an unlined earthen pilot discharge channel.

HYDRAULIC MODELS OF SPILLWAY YIELDED VALUABLE DATA

Investigations of the hydraulic features of the proposed spillway structure were conducted at the U. S. Waterways Experiment Station upon a model of the complete structure and appurtenant channels at a scale of 1 to 70, and upon a model of an interior section of the spillway at a scale of 1 to 25. The most important discovery resulting from this study was the fact that the converging chute walls of the original design caused the formation of standing waves which extended down the chute into the stilling basin, causing an unequal distribution of flow in the basin which could not be remedied by modifying the convergence of the walls or the design of the baffle piers. When the chute was redesigned with parallel walls, however, tests showed flow conditions to be satisfactory and stilling action to be improved.

In the stilling basin as originally designed, spray action occurred when the tailwater was lowered 1.3 ft below normal, sweeping the tailwater from the basin and causing scour tendencies greater than those concurrent with jump action. The tendency to spray action could not be economically corrected by lowering the stilling basin floor, and another solution was sought. A change in design introducing a vertical drop from the bucket of the chute to the stilling basin floor, was found to lower the elevation of the tailwater at which spray action occurred.

Structurally, the spillway contains several items worthy of mention. Reinforced paving 5 ft thick is provided for the chute, with expansion joints at 30-ft intervals, provided with copper water stops and I-beam dowels. The slab edge along the downstream side of each transverse joint is depressed 1/4 in. to avoid the possibility of developing dynamic pressure against it, and vents are placed across the chute, downstream from each transverse joint, to prevent the development of vacuum due to joint irregularities. The vents are extended up into the stems of the side walls and thence through the faces of the walls just below the top. The stilling basin slab was made 8 ft thick. The retaining walls are founded on sand, and are of the cantilever type, those in the stilling basin being 40 ft high. Clean sand from the required excavation was selected for backfill behind all walls when it was found that the use of this material in place of that taken at random would reduce the equivalent liquid horizontal pressure nearly 30 per cent. In addition to the economy in design, the smaller wall base width thus required made an appreciable saving in excavation. The entire structure has an extensive subdrainage system.

Construction of the dam and appurtenant structures will involve an estimated 13,815,000 cu yd of hydraulic fill, 2,945,000 cu yd of rolled fill, 82,000 cu yd of concrete, and 460,000 tons of riprap. Clearing of the reservoir and construction of the main dam is being done by government hired labor, the other operations by contract. The estimated cost of the project is $14,500,000.

Planning and construction of the entire project are under the direction of Harley B. Ferguson, M. Am. Soc. C.E., Brigadier General, Corps of Engineers, President, Mississippi River Commission, Vicksburg; and under the immediate supervision of Lieut. Col. Raymond G. Moses, C. of E., District Engineer, Vicksburg. For the design work, which was under the writer's charge, the Board of Consulting Engineers included W. H. McAlpine, William Gerig, Joel D. Justin, and O. N. Floyd, Members Am. Soc. C.E., and the late Louis C. Hill, Past-President Am. Soc. C.E. Captain Karl B. Schilling, C. of E., the project engineer, is in direct charge of all work in the field.

Flood Control of the Mississippi River

Historical Review Presented at the Society's 1939 Spring Meeting

By Harley B. Ferguson

Member American Society of Civil Engineers

Brigadier General, Corps of Engineers, U. S. Army; President, Mississippi River Commission, Vicksburg, Miss.

The present plan of flood control for the alluvial valley of the Mississippi River represents the culmination of two centuries of effort on the part of the people of the valley to provide for the safe occupancy of their lands—at first on their own initiative and later assisted by state and federal authorities. For an understanding of the events which led up to the formulation of the present plan of flood control, it is necessary to review briefly the early history of the settlement of the alluvial valley.

First Settlers Began Fight Against Overflow

The valley extends from Cape Girardeau, Mo., to the Gulf of Mexico, a total distance of 600 miles, and averages 50 miles in width. Built up from the silts deposited by Mississippi River floods, its fertile soil attracted settlers as early as the commencement of the eighteenth century. Coincident with this first settlement began the fight against overflow, by means of dikes, and through the subsequent centuries this fight has remained an inseparable phase of man's conquest of the valley. At first dike building was uncoordinated and aimed only at protecting individual properties. One of the conditions of the land grants from the King of France was that plantation owners build "levees" to protect their lands. Thus the French word "levee," signifying dike, came into current use. In the Louisiana parishes police juries made it mandatory for inhabitants living within seven miles of the river to work on the levees. In 1717 De la Tour, the engineer who laid out the city of New Orleans, directed "a dike or levee to be raised in front, more effectually to preserve the city from overflow." By 1727 the New Orleans waterfront was protected by a levee 5,400 ft long.

The early levees were small embankments, yet they served the purposes of that day because flood waters, even during great floods, seldom were more than a few feet deep on the high ground along the river, which was the only ground then under cultivation. By 1812, levees had been extended along both banks of the Mississippi River above New Orleans as far as Pointe Coupee on the west bank and the Bluffs at Baton Rouge on the east bank. By 1844 the west bank levees extended almost continuously to the mouth of the Arkansas River, 570 miles by river above New Orleans, and by 1858, small levees began to extend up one of the tributaries, the St. Francis River.

Early Problems in Levee Building

These early attempts at protection are of more than casual interest, for although they did not constitute flood control in the sense that we know it today, but were aimed at reclaiming lands periodically overflowed, this work had a profound bearing on the flood control problem that was to grow out of it in due course of time. In establishing his foothold in this rich alluvial valley, man merely exercised his inalienable right to protect the land he called his own against invasion by flood waters. This right, still recognized in law, was exercised through individual as well as through cooperative effort. It often resulted in conflict between interests, at times situated on opposite sides of the river, at times on neighboring plantations. One reason for this was the steadily increasing flood heights that resulted from the confinement of the flood waters, which formerly could spread in a thin sheet over the full width of the valley, but which now began to threaten those whose levees were low. Recognizing this evil, gaps were left in the dike system through which excess flood waters could escape into the low, as yet unoccupied, parts of the valley. In spite of this, many of the early floods were noted for levee failures caused by overtopping, crevassing, and bank caving at points where no flood waters were intended to escape. Raising low places in the levees merely resulted in transferring the danger points elsewhere.

The first attempts at standardization by prescribing grades for levee crowns and uniform cross-sections were made about 1850, when several states began to take a hand in levee building under the provisions of the Swamp Acts of 1849 and 1850. No great uniformity resulted, however, as each state established its own standards.

Methods Other Than Levees Studied

In the meantime interest grew in other modes of protection against high water: (1) diversion of excess waters at suitable points; (2) flood storage in headwater reservoirs, and (3) channel shortening by means of cutoffs. The first report dealing with these aspects was submitted by an engineer, Charles Ellet, in 1850. Although written 90 years ago, it is noteworthy for its careful evaluation of the worth as well as the limitations of these various methods. Ellet did not believe that levee grades could be established high enough to protect against the greatest flood which might occur, and stated that floods would increase in height and frequency as the result of increased occupancy of the valley. He considered levees as auxiliary to other flood-control methods. There followed the classical report by Humphreys and Abbot, dated 1861, which, though remarkable for its conceptions of river hydraulics, rejected reservoirs, cutoffs, and outlets as unsound and recommended adherence to protection by levees. This policy in later years became known as the "levees only" policy.

After the Civil War, during which all river work on the Mississippi had come to a complete standstill and much damage had resulted to the levee system through neglect, Congress in 1879 created the Mississippi River Commission. Its duties were to make surveys and prepare plans to improve the channel, protect the banks, improve navigation, prevent destructive floods, promote and facilitate commerce and the postal service. The Commission recommended levees to confine floods of most frequent occurrence as an aid to channel improvement for navigation. All levee work done under its direction up to 1917 was solely for these purposes. Up to that time flood control, in the modern sense, had not entered the picture, and navigation requirements and the postal service remained the only objectives for

which river improvements, including levees, could be built by order of Congress. After 1912 and 1913, which were disastrous flood years, the Commission established a system of provisional grade lines for the levees, which became known as the 1914 levee grades. It also provided standard cross-sections. Levee enlargement, however, did not progress rapidly because of limited funds and limited participation by the levee districts.

FIRST FLOOD CONTROL ACT—1917

It is important to note that although federal operations on the Mississippi River date from 1820, it was not until March 1, 1917, that Congress enacted what has become known as the first Flood Control Act. It authorized federal expenditures in the sole interest of flood control on both the Mississippi River and the Sacramento River in California. However, not until after the great Mississippi River floods of 1922 and 1927, which latter is considered to be the greatest recorded, did Congress, by Act of May 15, 1928, place itself definitely on record as recognizing flood control in the alluvial valley to be a national problem. Up to that time, the inhabitants of the valley had expended $292,000,000 of their own funds in the endeavor to protect their lands. By 1928 the population of the valley had grown to about 4,000,000; the two largest cities, New Orleans and Memphis, had, respectively, 450,000 and 250,000 inhabitants.

In the meantime steadily increasing confinement of flood waters by levees had caused flood levels to rise to considerable heights. A comparison of the highest gage readings of the flood of 1927 with those of 1882, also a very great flood, serves to illustrate in a general way the increase in flood heights during this 45-year interval. These amounted to $4^1/_2$ ft at Cairo, 13 ft at Helena, 13 ft at Arkansas City, $10^1/_2$ ft at Vicksburg, 9 ft at Angola, and 6 ft at New Orleans. As the 1927 flood lost much water through crevasses, and would have risen higher had it been completely confined, these figures are probably conservative.

The Act of 1928 was of a comprehensive character. In general, it provided for raising the levee system an average of 3 ft above the 1914 elevations and authorized the use of five floodways for diverting excess waters. It recognized the then undisputed fact that "levees-only" would not protect the alluvial valley. It provided also for the stabilization and enlargement of the river channel and so opened the door to the utilization of methods calculated to lower instead of to increase flood heights. Amendments to the Act of 1928, passed in 1936, 1937, and 1938, served to extend the 1928 plan to include flood protection along the principal tributaries within the alluvial valley, and to provide additional floodway facilities and flood storage reservoirs on the lower tributaries. The plan as it stands today is comprehensive in the sense that it protects not only against floods equal in magnitude to the greatest that have occurred, but also against the greatest that probably will occur. In substance, its aim is to accelerate the passage of flood waters into the Gulf of Mexico and to prevent flood stages from exceeding the limits of safe control by the levee system. Channel enlargement and diversion by means of floodways have made this plan workable, and experience to date indicates that it is sound.

NEW SYSTEM PASSED SEVERE TEST IN 1937

The first real test to which it was subjected occurred in 1937 when the system was called on to carry 2,000,000 cu ft per sec from Cairo to the Gulf. As the adopted plan made provision for carrying more than this total below the confluence with the Ohio, and 1,950,000 cu ft per sec below the mouth of the Arkansas River, with relief through floodways provided below both these points, the 1937 flood was a good test of the plan. In order to save Cairo from overflow it became necessary to operate the Birds Point–New Madrid Floodway, which had been provided specifically for that purpose. Below the mouth of the Arkansas River, however, where 12 cutoffs and dredging operations had shortened an original river distance of 330.6 miles by 120 miles in the $4^1/_2$ years preceding the 1937 flood, stage lowerings of as much as 12 ft on the Arkansas City gage were noted, and the discharge capacity of the leveed river had increased to such an extent that the floodway at this point did not have to come into operation. At Vicksburg, a lowering in stage over that existing before cutoffs were undertaken was noted, amounting to from 5 to 7 ft. At Natchez, similarly, the stage was lowered 1 or 2 feet. Naturally, reductions in stage were greatest at the upper end of the improved reach and grew progressively less in a downstream direction as the number of cutoffs and their cumulative effects diminished. Below Angola, the Bonnet Carre floodway was operated, diverting a maximum at 210,000 cu ft per sec. The stage at New Orleans was thus prevented from exceeding 19.3 ft, which was 0.7 ft below the prescribed 20-ft maximum.

PROGRESS IN CUTOFF AND DREDGING PROGRAM CONTINUES

Since the 1937 flood, two years have elapsed during which no very high stages have been witnessed; 1938 crest stages were mostly around bank-full and less; and the 1939 flood was but little higher. Both high-water seasons, however, were characterized by long-continued flows in the neighborhood of 1,000,000 cu ft per sec, which proved effective in producing appreciably further changes in the stretch of river under improvement. At Arkansas City and at Vicksburg additional stage lowerings of from 2 to 3 ft were noted in 1939 over those of 1937. The progress so made since the inception of the cutoff and corrective dredging program in 1932 is best noted by comparing the 1939 flood with stages obtained during rises in 1929 and 1932. Comparing the rating curves at Vicksburg, Miss., at a flow of 1,300,000 cu ft per sec, the March 1939 rise is lower by 7 to 9 ft than either 1929 or 1932 at this flow. At Arkansas City a preliminary crest in 1929 and the 1932 flood reached approximately the same flow at about 1,430,000 cu ft per sec, and the same gage height at about $53^1/_2$ ft. On March 5, 1939, the crest discharge was almost identical with these two floods before cutoffs and channel improvement work and yet the stage was only 38 ft—a lowering of over 15 ft at Arkansas City as compared with 1929 and 1932. In terms of discharge capacity, the river at bank-full stage carries today 420,000 cu ft per sec more at Vicksburg than in 1929, while at Arkansas City the increase appears to be more than twice this amount.

Since 1937, one cutoff, which effects a 15-mile shortening, was placed in operation above Arkansas City. As a result, the Helena gage, about 40 miles above Arkansas City, now shows a slight lowering. The progress of the cutoff and dredging program taken year by year as yet gives no indication of material slacking off in the matter of stage lowering. There is no evidence that stages have been raised at any point. It should be borne in mind that up to the present time none of the cutoffs has attained its ultimate enlargement. The end of the possibilities for improvement is therefore not yet in sight and there is every reason to believe that further material relief can be attained by continuing the work for some years.

The Construction Program of the TVA

General Objectives; Administrative Features of Engineering Organization; Accomplishments to Date

By Theodore B. Parker, M. Am. Soc. C.E.

Chief Engineer, Tennessee Valley Authority, Knoxville, Tenn.

Established in 1933, the Tennessee Valley Authority has already completed three major dams, and five others are currently under construction. For economic reasons, all of this work is being done by force account. The engineering organization numbers over 1,000 engineers and assistants and 400 clerical employees, and an average of more than 7,000 hourly paid employees are engaged on construction work. In the accompanying article Mr. Parker sketches briefly the general objectives of the TVA, describes the administration of its vast engineering organization, and surveys its achievements. The paper is an abridgment of one presented by Mr. Parker at the general session of the Society's 1939 Spring Meeting.

The first improvement of the Tennessee River by the federal government was undertaken more than a century ago when Congress in 1828 authorized surveys and estimates for a canal and locks around Muscle Shoals. Navigation was the only problem the river presented for solution by the federal government between 1826 and 1899.

From about 1900 until the World War, various proposals for hydro developments in the Muscle Shoals section figured in nearly every session of Congress. In 1917 the construction of Wilson Dam was authorized as a war-time measure. This dam was finally completed early in 1926. The construction of Lock and Dam No. 1, a small navigation project $2^1/_2$ miles downstream from Wilson Dam, was authorized by Congress in 1925 and completed shortly afterwards. The Tennessee Valley Authority was established by Congress May 18, 1933, to provide for the development of the Tennessee Valley in general and the Tennessee River system in particular.

The TVA received into its charge a river which had great possibilities, but which in its natural state was difficult to utilize in the public interest. This difficulty was due mainly to the wide fluctuations in stream flow, which at Wilson Dam ranged from a minimum of less than 5,000 cu ft per sec to floods of 440,000 cu ft per sec and more.

The Tennessee River is potentially a valuable transportation medium for a large section of the southeastern United States. It is not an isolated stream, but can form an integral part of the interconnected inland waterway system of the Mississippi River, comprising 6,000 miles of 9-ft navigable channel. During low flow, however, navigation on the Tennessee was practically impossible.

Flood flows from the uncontrolled river presented a serious problem in the Tennessee River basin itself (as at Chattanooga) and also contributed substantially to floods along the lower Ohio and Mississippi. In the great floods on the Ohio from 1897 to date, the Tennessee has contributed from 140,000 to more than 450,000 cu ft per sec at the crest.

The Tennessee drains an area of heavy runoff, and has a total fall from head to mouth of 500 ft. It has, therefore, great power possibilities, but this is again contingent upon regulation of stream flow. Prior to the creation of the TVA, the Wilson Dam and the Hales Bar Dam were the only power developments on the main river. Wilson has an initial capacity of 184,000 kw, with provision for an ultimate 444,000 kw; prior to the development of upstream storage, however, the continuous power there was only 40,000 kw.

The basic plan of the Authority is to develop the Tennessee River system in a comprehensive way that will take full advantage of its potentialities, and will not interfere with any important anticipated use of the river. Our plans for the construction of dams include seven on the main river and two on the Clinch and Hiwassee tributaries. (See Fig. 1 and Table I.) Three of these have been completed and five others are now under construction. These projects, providing navigation, flood control, and power benefits, conform in general to the recommendations of the Chief of Engineers,

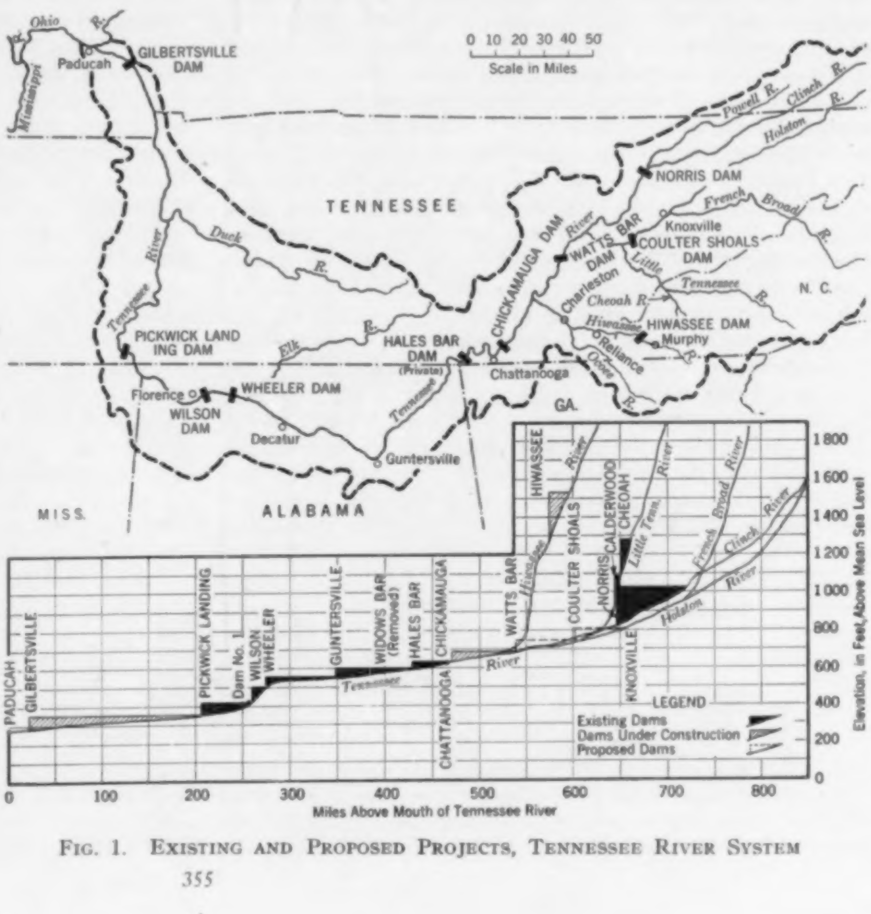


Fig. 1. Existing and Proposed Projects, Tennessee River System

U. S. Army, in his report dated March 15, 1930. Adequate flood storage to provide desirable flood protection in the Tennessee Valley will require the construction of additional reservoir projects on at least two of the other three principal tributaries—the Holston, French Broad and Little Tennessee rivers.

TVA's engineering organization is made up of over 1,000 engineers and assistants and 400 clerical employees. In addition there has been an average of more than 6,000 employees paid by the hour on construction work. The administrative features of such an undertaking are proportionately important; and in this connection the organizational chart, Fig. 2, is of interest.

TABLE I. DATA ON TENNESSEE VALLEY AUTHORITY DAMS

	Max. Height Ft	Over-all Length Ft	Concrete Cu Yd	Earth Cu Yd	Power Kw	Reservoir Capacity Acre-Ft	Status as of June 1939
Norris	265	1,860	1,002,000	72,000	101,000	2,567,000	Completed (1936)
Hiwassee†	308	1,265	760,000	0	115,000	435,000	Under construction
Pickwick Landing	113	7,715	621,000	2,687,000	216,000	1,032,000	Completed (1938)
Wilson	137	4,860	1,240,000	0	444,000	600,000	Completed (1926)*
Wheeler	72	6,342	627,000	0	259,000	1,115,000	Completed (1937)
Guntersville†	94	3,985	300,000	820,000	97,000	951,000	Under construction
Chickamauga†	108	5,794	475,000	2,200,000	108,000	639,000	Under construction
Gilbertsville†	150	8,655	1,225,000	2,620,000	160,000	6,100,000	Under construction
Watts Bar†	95	2,900	500,000	550,000	150,000	1,132,000	Construction starting

*Built by U. S. Army Engineers. †Preliminary estimates.

The Water Control Planning Department prepares the general plan for the utilization of water resources in the Tennessee River valley and supervises operations in so far as the control of stream flow is concerned. The River Control Section prepares instructions to control the reservoirs for the unified system operation for navigation, flood control, and power. The Flood Control Section studies the flood control problems of the system. The Power Section makes power studies in connection with the preliminary investigation of the Tennessee River and tributaries. The Hydraulic Data Division makes stream-flow and rainfall measurements in cooperation with other government agencies. In addition it makes river stage forecasts, silt investigations, spring measurements, and evaporation measurements, and also maintains a hydraulic laboratory. The Maps and Surveys Division performs surveying and mapping work and prepares precise land descriptions for property acquisition. The Geologic Division investigates dam sites and examines mineral claims on lands to be acquired by the Authority. The Project Planning Division studies the Tennessee River and tributaries with respect to navigation, flood control, and power and prepares preliminary plans for the engineering features of the various projects contemplated by the Authority.

The Design Department is responsible for the design of structures to be built by the Authority. It is expected to design within the general pattern, and according to the hydraulic requirements, established by the Water Control Planning Department. The Engineering Contracts Division prepares specifications and engineering contract documents, inspects and tests material and equipment, and develops standards to coordinate design with manufacturing practice. Individual project design divisions prepare the designs for the construction of the projects. The technical staffs review designs and prepare standards. The Drafting Service Division makes tracings of finished design drawings and operates a blueprint shop. The Highway and Railroad Division plans and designs all such structures built or relocated by the Authority.

The Construction Department is responsible for constructing the facilities designed by the Design Department. Should the nature of the design lead to high construction costs, or should information obtained in the course of construction point to economies obtainable by design revisions, the two departments cooperate in completing a more satisfactory design. In order to centralize responsibility, a separate construction division is set up for each project. Each of these divisions is divided into three sections—engineering, construction, and accounting—headed, respectively, by a construction engineer, a construction superintendent, and a project accountant. The Construction Plant Division is responsible for the development of the plant at each project and maintains records of its performance, valuation, and availability. It also analyzes construction costs and the economies of construction operations. The Construction and Maintenance Division performs such construction and maintenance work as may be assigned to it—principally construction camps, roads, and water and sewerage systems. The Reservoir Clearance Division prepares the reservoirs for flooding.

No discussion of the engineering organization would be complete without emphasizing the high caliber and character of the individuals who comprise the various staffs. The large and unprecedented program of the Authority made the work virtually an engineer's paradise—and since the TVA was created at a time when engineering and construction activities throughout the

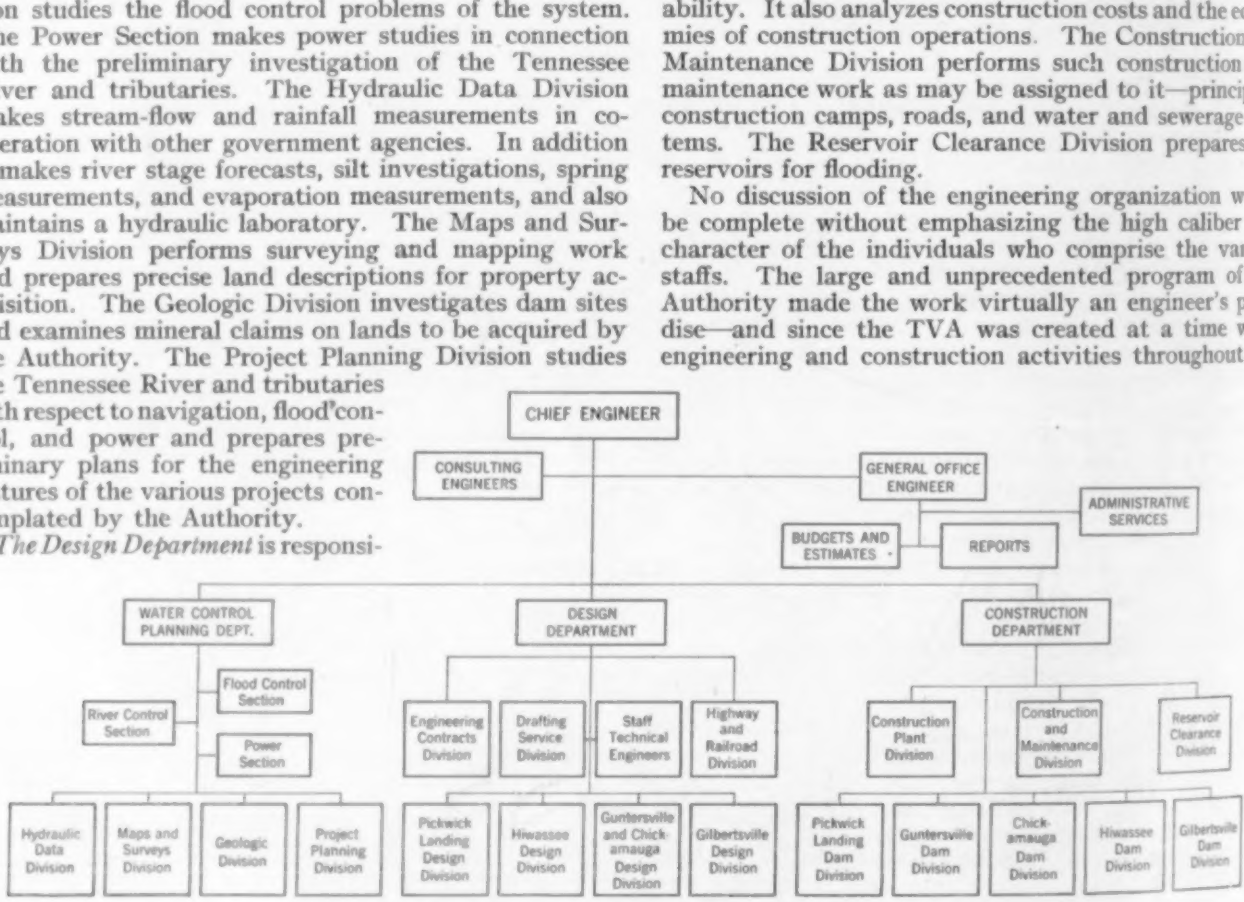


FIG. 2. DEPARTMENTS OF TVA FOR WATER CONTROL IN THE RIVER CHANNEL

country were at a very low ebb, the Authority was able to recruit an extremely able group of men. These men have been primarily interested in seeing the job done well, and they, rather than the organizational setup, are responsible for the results achieved.

From the start it appeared that the major projects of the Authority could best be constructed by force account. Five years of experience has confirmed this belief. Exploration of sites, preparation of preliminary plans, and design of the Authority's dams have followed one another so closely that it would have been difficult to complete designs, issue plans and specifications, and advertise for bids, all within the time available. It has been found more feasible to complete plans as expeditiously as possible, and to release them to the field somewhat in advance of construction. This has permitted economical revisions where necessary and flexibility of design to meet actual field conditions.

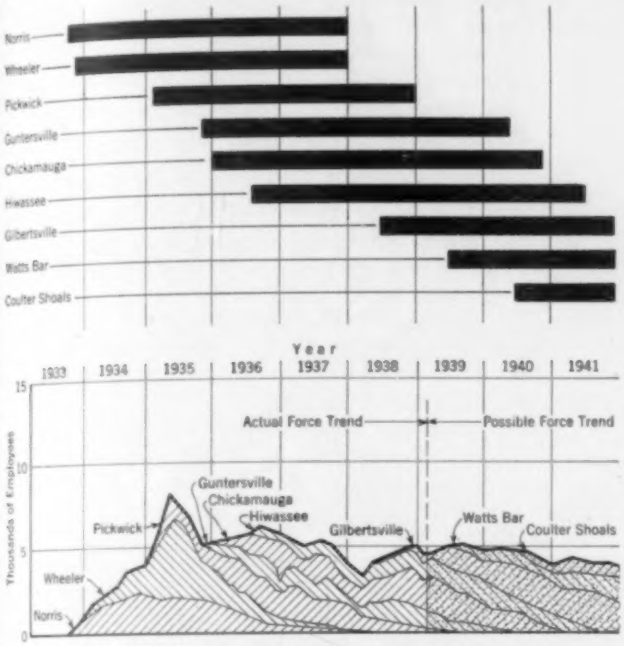


Fig. 3. Continuity of Projects Through Scheduling

Most dam construction involves foundation difficulties and uncertainties as to cost of unwatering the site. Bidding on such work is a gamble at best, and at worst frequently involves extensive litigation and losses to both contractor and owner. There are therefore obvious economies in carrying on this work by force account, provided an adequate construction organization is available.

Where a continuous program involving so many major projects is in progress, there are increased advantages in force account work. Such a program in itself justifies the assembling of special construction personnel and equipment. In the Tennessee Valley we have had at all times during the past four years at least three, and usually four, major projects under active construction. By employing our own forces on this work, we are able to realize the economies resulting from a large volume of construction and continuity of operations.

The work of the major construction divisions is restricted to the dams and appurtenant structures. Construction work in the reservoirs, involving largely the relocation of highways and railroads, is either let by contract, or undertaken by the Construction and Maintenance Division.

Much of the accomplishment of the TVA construction forces has been due to the efforts of the workers on the various jobs. The Authority has encouraged cordial relations with all employees and this has been reciprocated by them, particularly through the local and international labor organizations. All differences between labor and management have been settled by negotiations and adjustments so that the work has proceeded without interruption or difficulty from this cause.

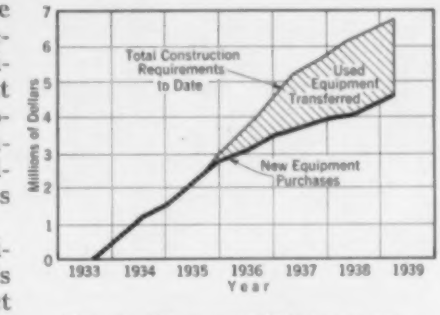


Fig. 4. Equipment Economics by Transfer Between Projects

By proper scheduling of work it is possible to conduct large-scale and diversified operations in such manner as to level extreme peaks and valleys in procurement and personnel demands. Figure 3 shows the outline schedules for the construction program of the Authority in so far as Congress has authorized construction or investigation. The spacing of projects is predicated upon an even schedule of appropriations and is designed for a steady utilization of men and materials. Schedules for design, procurement, and construction are of course interrelated, and must be worked out together for the best results. Projects are arranged to permit the work that is most dependent on river flow to be undertaken at the most strategic times.

By means of an equipment placement chart the management is kept graphically informed of the location of all important equipment, and can easily comb every possible internal source before purchasing additional units. Where it is economical to do so, schedules are adjusted to make present equipment available. Occasionally, equipment is temporarily rented until needs can be supplied by transfer from another project. In purchasing new equipment, items offered by the various vendors are rigidly compared and evaluated. In many cases, after equipment has been placed in operation, periodic studies are made to determine when it is more economical to dispose of it than to keep it in use. In Fig. 4 are shown the savings that have resulted from transferring equipment from job to job.

The safety of TVA workers is considered of prime importance; favorable working conditions are provided, and workmen are trained to avoid accidents. In the early stages of the construction work, the frequency and severity rates of accidents were high. An extensive safety program was accordingly inaugurated in the summer of 1934, and a steady reduction in frequency and severity rates has been the result (see Fig. 5). During 1936 the four dam construction operations—Norris, Wheeler, Guntersville, and Hiwassee—were designated "honor roll companies" by the National Safety Council for outstanding safety achievements in their respective industrial groups. Several other honor roll ratings were given Norris, Guntersville, Wheeler, and Pickwick Landing, both in dam construction and reservoir clearance operations, in 1935 and 1936, and also in 1937, the last year for which data are available.

Designs of principal structures follow two general patterns (Fig. 6). The high dams so far constructed on the tributaries—Norris and Hiwassee—are gravity concrete structures with both controlled sluices and crest gates. The power houses are close to the dams, and are equipped with vertical generating units of conventional

type. On the main river, the normal heads developed range from 50 to 70 ft. Each of these dams consists, in general, of a central spillway section in the channel, flanked by earth dikes extending across the flood plain. The spillways are made up of large steel flood gates car-

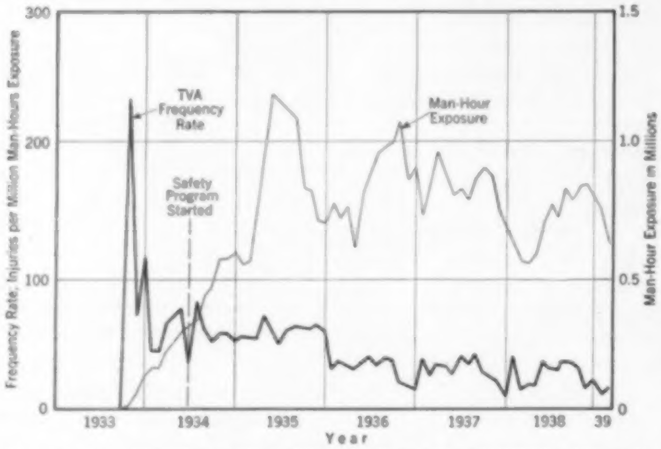


FIG. 5. FREQUENCY RATE FOR "LOST-TIME" INJURIES ON TVA LOCK AND DAM PROJECTS

ried on concrete piers, and generally operated by overhead gantry cranes. A navigation lock is built initially at each main-river dam, with provision for the future construction of a second lock. The water wheels of these dams are of the propeller type, usually with adjustable vanes.

In 1933 there were 80 miles of nominal 9-ft channel in the Tennessee River system; today there are 250 miles of 9-ft channel. Upon completion of the 10-dam system, including Wilson, this will be increased to 650 miles.

Prior to 1933, the minimum flow in the lower river was about 5,000 cu ft per sec. The minimum flow can now be held up to 18,000 cu ft per sec. Additional storage developments will further increase this.

In 1933 the seasonal storage available in government projects was negligible. Today the total reservoir volume is about 6,000,000 acre-ft. Upon completion of the 10-dam system, the total volume will be in the neighborhood of 15,000,000 acre-ft, of which 9,000,000 can be used as controlled flood storage.

The installed power capacity in government projects amounted to 184,000 kw in 1933, all at Wilson Dam; it is now 420,000 kw, and may ultimately exceed 1,500,000 kw.

The essential basis for the very real economies being effected through the TVA construction program lies in the multiple-purpose nature of the enterprise. The advantages of this scheme of development cannot be overemphasized. From a single system of dams and reservoirs there are being realized three principal objectives—navigation, flood control, and power. The cost of this tri-purpose construction is much less than the total cost of separate navigation, flood control, and power systems. For the three TVA dams first put into operation—Wilson, Norris, and Wheeler—the present value or actual investment is $94,000,000. The total cost of providing equivalent but separate benefits for navigation, flood control, and power would have been about $160,000,000. Similar economies will be realized as the development of the river proceeds.

The allocation of the cost of these three projects is: power, 52 per cent; navigation, 28 per cent; and flood control, 20 per cent. On this basis the government has secured a navigable stretch of river for less than 60 per cent of what it would have cost as a separate project. It has secured a considerable amount of flood control storage at a cost of $7.50 per acre-ft, which is considerably less than the cost of the majority of flood control projects so far proposed. The indicated cost of generating capacity is about $141 per kw, which compares very favorably with the cost of equivalent hydroelectric generating capacity elsewhere.

The allocation just referred to is a necessary and convenient means of appraisal. It is not in itself, however, a measure of the fundamental economy of this enterprise. Material changes in the methods upon which this allocation is based, or even considerable changes in the allocations themselves, would not affect the basic economy of this enterprise. For example, had as much as 65 per cent of the total costs been charged to power, the unit cost per kilowatt would be increased from $141 to only about $175, which still compares favorably with other hydroelectric capacity costs. On the other hand, had the power allocation been reduced to 35 per cent, the cost of navigation would still remain considerably below any equivalent cost for navigation alone, and flood control charges would not exceed $12 per acre-ft.

The basic economies inherent in the TVA program thus result from three principal factors: (1) the comprehensive development of an entire watershed; (2) maximum returns from a single set of structures, due to multiple-purpose development; and (3) a consistently planned and consecutive construction program.

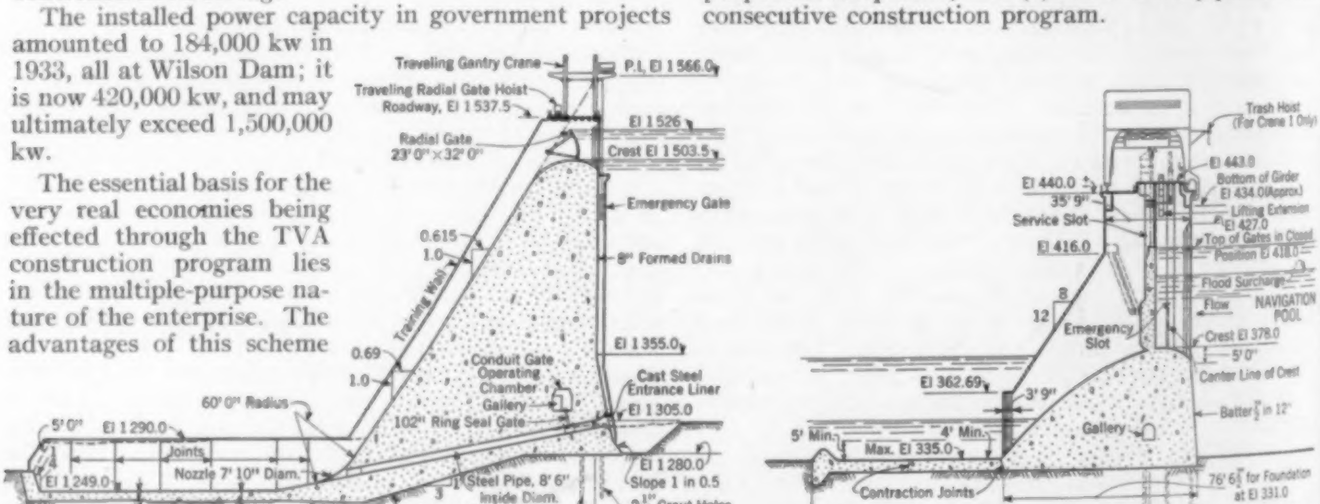


FIG. 6. CROSS-SECTIONS OF TYPICAL TVA DAMS

Left: A Tributary Dam (Hiwassee); Right: A Main River Dam (Pickwick Landing)

Trends in Boundary Surveying

By A. H. Holt, M. Am. Soc. C.E.

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JIGSAW puzzles of the parlor variety are interesting, says Professor Holt, but he holds no brief for their large-scale counterparts on the ground—those hodgepodges of boundary description that are the bane of every surveyor's existence. Happily, boundary surveying appears currently to be receiving more of the studied attention it so thoroughly deserves. The purpose of the present article is to call attention to the definite progress that has been made in the past five or six years, and to suggest steps that should be taken to insure a continued development along sound lines. In this development the adoption of state plane coordinate systems, the extension of local control surveys, the improvement of field methods, and cooperation with the legal profession all have a part. This article is abridged from the paper presented before the Surveying and Mapping Division at the Society's 1939 Spring Meeting in Chattanooga.

BOUNDARY surveying must serve a considerable number of ends. Within that term, for the purposes of this discussion, I now mean to include all those items, whether of field or of office, that make it possible to ascertain, to describe, and to indicate on the ground the boundaries of any given tract, and to know conclusively its position with relation to other near-by tracts. This makes the term include not only the incidental engineering measurements, which might in the minds of some persons constitute the whole of "surveying," but the vastly more difficult matters of so relating these measurements to the corresponding ones for other tracts that at least two things can be done: It must be possible and reasonably convenient, at any time in the future, for any competent engineer to retrace on the ground the footsteps of him who by his "description" has attempted to identify the land. And it must be possible and reasonably convenient for any competent examiner of title to so identify the parcel whose description he reads that he can not only trace that parcel through successive conveyances but also be able to see how it fits with others near by, with no overlaps and no gaps between. Jigsaw puzzles may be interesting, but their large-scale counterparts on the ground are not to be desired—particularly when it is finally determined that the most skillful use of the pieces will produce only an incomplete and distorted picture.

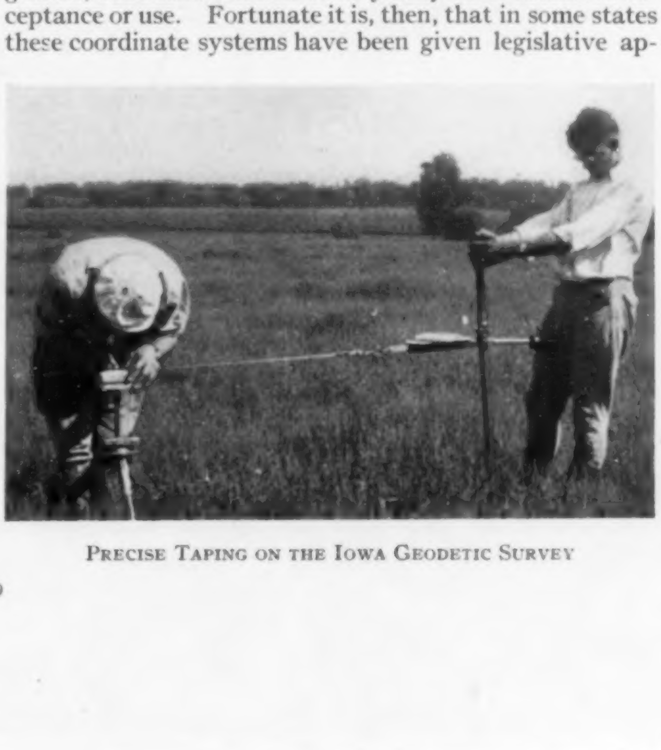
It has long seemed to me that it is worth while to do well those things that are essential to these two ends, and that their accomplishment is worthy of the care and skill of high-grade men. It is therefore a source of considerable satisfaction to me that there has developed, within the last five or six years, an attitude of attention to and respect for this work which is in decided contrast to that of former years. Within this period much real progress has been made, and the foundation has been laid for more good work to come. That this growth may not be sporadic, and that something of lasting and increasing value may develop, it is wise for all concerned to think clearly, critically, and constructively about these current trends in boundary surveying.

One of the bits of good blown in on the ill wind of the depression and the consequent unemployment of engineers, was the initiating, in the fall of 1933, of a more extensive program of control surveys than this country had previously known. Not too much was to be expected of an undertaking having as primary object the relief of unemployment rather than efficient engineering; but much of the direct result was good, and some things that at first appeared incidental, or in the nature of by-products, are now seen as of major importance.

Foremost among these I should mention the state systems of plane coordinates. Whether or not they would have been generally developed, or whether, if developed, their use would have gained much headway without the impetus of the CWA and succeeding surveys, I am in no position to say. At all events we have them, and, their use potentially provides the most promising, most practical single means that has been available in this country to assist in accomplishing the ends of boundary surveying.

It is not suggested that there is anything radically new about plane coordinate systems or about their use in boundary description. But the production of unified systems for whole state areas is a positive step in advance. That this has been done in such a way as to preserve the practicability of high precision even though positions are expressed in the widely familiar terms of linear measurement, is a matter of great credit to those who are responsible for devising the systems. The unity of these systems, and the important fact that they are definitely, conveniently, and precisely tied to the national control net of triangulation and traverse, are two of their most promising characteristics for permanent and useful service in boundary surveying.

It would seem that nothing less comprehensive than a state-wide, completely defined, single system should deserve official recognition by legislative enactment, or the quasi-official recognition implied in use by an official court, authority, or other agency. Nor does it seem probable that without such official sanction, or such semi-official use, anything of the nature of coordinate systems would generate in the minds of property owners, courts, lawyers, title examiners, or even of engineers, sufficient confidence to justify their extensive acceptance or use. Fortunate it is, then, that in some states these coordinate systems have been given legislative ap-



Precise Taping on the Iowa Geodetic Survey

proval and a legal status; and that in others where this formal recognition has not as yet been accorded, their extensive use by influential organizations has almost been tantamount to such action. It is fortunate, also, that full and effective use of these systems by persons who are concerned with other aspects of boundary problems than those of engineering, as well as any and all use for the purposes of routine surveying, need not involve any mathematical considerations beyond the use of two distances at right angles to each other for the location of a point.

TRIANGULATION ON THE CLEVELAND GEODETIC SURVEY

In evidence of official recognition of the state coordinate systems, several states have adopted so-called enabling acts. Most of these acts follow rather closely the same form. Their purposes are to define officially the system for the state in question by stating the nature of the projection, the positions of the coordinate axes, and so forth, as these are given by the U. S. Coast and Geodetic Survey; to give it an official name; and to restrict the use of that name to references to the state system. Some of the acts go one step further with a very desirable clause which establishes a limit of distance beyond which it is not permissible to carry surveys of lower than second order if the coordinates of points determined thereby are to be incorporated in land or deed records. Further than this these acts have not gone. They therefore impose no requirements. They do regulate to a minimum extent any use of the coordinate systems which is to reach the land records, and thus they pave the way for a growth which should be without confusion and should develop nothing to be undone. It is hoped that other states will soon follow the examples of New Jersey, Pennsylvania, and New York, and place on their statute books such an act as will accurately define and name the state coordinate system, adding thereto such regulation as local judgment may dictate.

EXAMPLES OF QUASI-OFFICIAL USE OF COORDINATES

As instances of the quasi-official use of these coordinate systems, two examples may be cited: (1) The Massachusetts Land Court has long used isolated plane coordinate systems for expressing the positions of points in connection with the description of registered lands. As fast as is practicable, these coordinates are being replaced by coordinates on the state system, and wherever the existence of control-survey stations makes it possible to do so, state plane coordinates are used as a part of new descriptions. (2) In describing the many tracts of property whose transfers have been involved in the operations of the Tennessee Valley Authority, state plane coordinates are used throughout.

Two major types of land description are of course well recognized—one, which names a parcel or a fraction of a parcel, and the other, the description "by metes and bounds." The greatest use of the former is to be found where the Public Land Surveys have been executed. Most of the descriptions by both the Massachusetts Land Court and the TVA are, directly or indirectly, by metes and bounds. In Massachusetts the practice is to give such a name to the parcel in the deed description, or to so state the names of the adjoining owners, as to identify the parcel in a general way but not to define it precisely. A plat, incorporated by reference, invariably accompanies such a description; and on the plat ample data are given to facilitate the identification, or if necessary, the resetting, of the monuments. The usual practice of the TVA, on the other hand, is to give a full metes and bounds description of the boundary in the deed, which is thus made complete without an annexed plat.

Obviously, either of these methods produces an adequate description. I was once of the opinion that the coordinates of the corners should be included in the word description, substantially as is done by the TVA. It still seems to me that if no plat is to be filed, this should be done. However, the practice of the Massachusetts Land Court, when it can be made effective, would seem to be the better. This requires that a plat be incorporated by reference in every description. It does not mean that a survey and plat must be made every time a deed is drawn, but it does require that there be a recorded plat of the land to which the description applies, and that the description include a reference to the plat in such a way as to make it a part of that description, and hence of the deed or other instrument in which the description is contained. To make such a practice fully effective, there should be some constituted authority whose duty it is to pass on the sufficiency of a plat before it is permitted to be recorded. It is to be noted that the use of a plat to accompany a word description makes it equally convenient to use plane coordinates of the controlling points on a boundary, whether the description is of the type that names a parcel or fraction of a parcel, or a description of an irregular tract by metes and bounds. The system is equally useful in the public land states or in the older, eastern part of the country.

Obviously no such system can be suddenly and universally imposed by legislative action in any given area. The first requirement is a competent approving agency. Then the use of plats must be brought in gradually in some manner—perhaps by requiring a plat for any land whose title is to be registered, perhaps by requiring one for any transfer of interest in land of unit value higher than a stated amount. Gradually the requirement should be extended, until, when the ultimate objective is reached, any instrument creating or affecting an interest in land would be required, if it is to be recorded, to refer to an acceptable accompanying or previously recorded plat.

To have suggested such an objective as this ten or fifteen years ago would have been to invite ridicule. The proposal would have been regarded as fantastic, economically impracticable, and of doubtful value with the then-existing control surveys. Perhaps in many quarters it will still be so regarded. A very similar requirement, however, has for many years been imposed by the Massachusetts Land Court on land whose title is being investigated for registration.

It should be realized that the use of plane coordinates for land description is still new and strange to many people. It is important then, in order that the use of

coordinates may be tolerated where they are not understood, that descriptions, no matter how they are accomplished, be so constructed as to be sufficient without the coordinates which they contain. It should be made clear—and this is not easily done—that the introduction of coordinates does not require the substitution of a new form of description for the old familiar forms. It simply means the providing of another and a more reliable method of finding at a future time on the ground the original monuments which mark the bounds of the property, or of accurately locating their places if they have been removed. This work of education needs the best and most patient efforts of all who believe in the efficiency of this coordinate plan.

Another development from the earlier control surveys is seen in the great extent of local control surveys now in progress under the joint sponsorship of the Works Progress Administration and, in each case, some agency of a municipality. A very large sum of federal money, some $50,000,000, has been made available for this work, and much good should result. These surveys are conducted under the specifications embodied in "Technical Procedure for City Surveys" (Manual of Practice No. 10 of the American Society of Civil Engineers), and are intended to be of a very high precision. Their objectives, so far as boundaries are concerned, usually include the monumenting of block corners (if not already done) and the determining of the coordinates (on the state coordinate system) of those corners, and of additional control monuments.

For example, it is stated that about 170 projects are to be carried out in the state of Massachusetts alone, most of them including boundary control as one of their principal purposes. Another outstanding project is the Cleveland Regional Geodetic Survey, covering Cuyahoga County, Ohio. It was begun in July 1937, and is still in progress. The triangulation on this survey is about half completed. Traverse work has recently been begun. Several hundred miles of first-order levels have been run and adjusted, and second-order levels are to put a bench mark within half a mile of any point in the county. About a thousand very heavy precast concrete monuments will have been set by the time the work is completed. Topographic maps to a scale of 200 ft to the inch are to be made by plane table. The entire survey will finally be expressed in terms of the state plane coordinate system, which will thus be made available for the description of boundaries throughout greater Cleveland and Cuyahoga County.

It would seem to be fundamentally essential that in any area there should be the fullest cooperation among all agencies engaged in making control surveys—not only to avoid needless duplication and consequent waste of funds, but to correlate the results and to prevent the publication by two different agencies of data that are not entirely in agreement. The latter is not justifiable on any grounds. It is entirely reasonable that subsequent surveys in any area, if and when higher precision is needed, may give different and better values for the positions or elevations of control monuments than those at first determined. If and when this need develops, and when it has been clearly demonstrated that the greater precision has been attained, all agencies should join in publishing a definite revision, clearly stated. Simultaneous publication or use of conflicting data can only tend to discredit in the eyes of other professions the use by engineers of control data for boundary description.

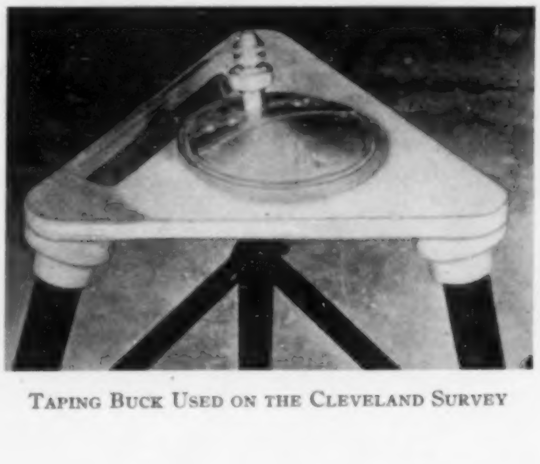
This possible revision of data concerning positions of control stations points to the desirability of so dating or otherwise earmarking the coordinates used—for example, in a deed description—that if a revision is made in the future the proper equation can be determined and applied to the old data so as to make them currently usable. This is like a statement in a report or on a drawing where elevations are used that a given elevation is referred, for example, to "the Fourth General Adjustment of the U. S. Coast and Geodetic Survey (1912)." The bench mark under consideration may have a different elevation according to the 1929 General Adjustment. This does not produce any confusion, however, provided the statement just referred to has been clearly made. If, on the other hand, two sets of elevations were published at about the same time by different agencies, differing, if even by only slight amounts, because of absence of correlation of work, confusion and uncertainty would be likely to result. If others than engineers have occasion to observe any such confusion of basic data they may not be charitable in their opinions concerning the reliability of the data for such long-time use as that of land description.

Current Trends in Field Work

Turning now to a consideration of current trends in the field work of boundary surveys, we find the variations from older practice expressed chiefly in greater precision of ground surveys, or in the wider use of ground surveys of high precision, and in the increasing use of methods involving aerial photography. The former is an entirely natural development. The latter finds its chief application, so far as boundary work is concerned, in surveys of lands of low unit value. A special application of this latter method is found in cases where tracts of not too high unit value are being acquired only to be merged. Special procedures which were particularly efficient for such conditions have been worked out and used in the land acquisition work of the TVA, where thousands of parcels have been acquired. Surprising accuracy has been attained.

In securing flowage areas for the pools involved in the canalization of the Upper Mississippi, a very large number of parcels of irregular shape have been acquired. Here, transit and tape surveys have been used exclusively, closed traverses being run and tied in to control traverses which had in turn been connected to the federal control system. Permanent monuments have been used to mark the exterior boundaries of areas acquired. State plane coordinates were not used, but the positions of the monuments have been so related to the federal control that their coordinates can be obtained without further field work.

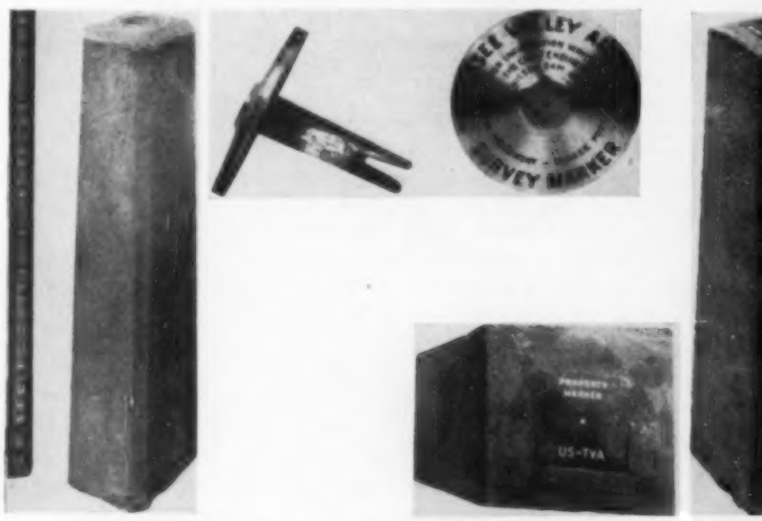
In obtaining the land to be acquired by the United States for flood control purposes in the vicinity of Pittsburgh, Pa., complete control surveys have been made. (See "Control Surveys for Flood Protection Projects in the Pittsburgh District," by Thomas J. Mitchell, M. Am. Soc. C.E., Civil Engineering for May 1939.)



Taping Buck Used on the Cleveland Survey

Critical points on boundaries (which are usually recognizable only from streams, stone walls, or other lines of occupation) are tied in to the control; and the descriptions and areas are obtained by computation. Pennsylvania state coordinates are used throughout.

Another outgrowth of the quickened interest in boundaries and landmarks which accompanied that in control surveys is the work in progress in some states to recover and re-mark the corners established in the



PRECAST CONCRETE SURVEY MONUMENTS USED BY TENNESSEE VALLEY AUTHORITY, WITH DETAILS OF MARKER PLATE

original survey of the public lands. In the older states few of the original markers remain, and those that replaced them are very miscellaneous and usually of destructible character. Many have been obliterated and some lost. The re-marking projects that are in progress do not usually attempt to reestablish lost corners; but a thorough search is made when necessary, to disclose all existing physical evidence of the original location of the corner. When that location can be ascertained, the point is re-marked with a distinctive and lasting monument, and surveys are conducted to establish its position on the state coordinate system. This having been done, and the data having been made a part of conveniently accessible public records, there should never again be any uncertainty as to the location of the corner, or any difficulty in finding it.

COOPERATION WITH LEGAL PROFESSION

Along with the more general recognition by the engineering profession of the value and requirements of proper boundary work, has come cooperation on the part of representatives of the engineering and legal professions which is one of the most potent assurances of better boundary work in the years to come. One example of this cooperation is the work of the Joint Committee on Land Surveys and Titles to which representatives have been appointed from the Surveying and Mapping Division of the American Society of Civil Engineers and from the Real Property Law Division of the Section of Real Property, Probate and Trust Law, of the American Bar Association. One valuable point is scored by the simple recognition of the fact that matters of boundary survey and of land title constitute but two aspects of one problem, and that they should be considered together in that light.

For some two years this Joint Committee has been seriously trying, first, to define what its objectives should be, and, second, to devise and recommend feasible means for attaining them. The First Preliminary Report of the Committee was published in the November 1938 PROCEEDINGS of the American Society of Civil Engineers, and in the Report of Proceedings of the Fifth Annual Meeting (July 1938) of the Section of Real Property, Probate and Trust Law, of the American Bar Association. In addition, it has been given wide distribution among people concerned with title to land—such as mortgage commissions, title examiners, officials of loan associations, and so forth; and it is hoped that it will stimulate both a realization of some of the needs for satisfactory land survey and title conditions, and an interest in providing them.

With this Joint Committee has been merged the Committee on Boundaries of the Surveying and Mapping Division, since it was felt that the work of the latter is properly a subdivision of that of the former.

The chief recommendations of this Joint Committee thus far, as expressed in its First Preliminary Report, may be briefly stated to be: (1) the use of the state coordinate systems for expressing the positions of points on boundaries, and (2) the establishment in each state of some sort of agency, bureau, or official, to be charged with the duties of administering this use of coordinates, and of assembling, preserving, and disseminating all available survey data pertaining to the area within the state. Survey data are of value only when their existence can be ascertained, and their usefulness is directly related to the certainty and convenience of ascertaining them.

Engineers who have made resurveys of boundaries are all too well acquainted with the extent, the haphazard character, and the final uncertainty of the efforts now required to assemble the necessary data for relocating the boundaries of a tract of land. Frequently such a resurvey is now quite out of the question unless a considerable period of practice in a particular community has enabled the engineer to accumulate privately unofficial data from which further work can be extended, or to which it can be made to conform.

The bureau whose establishment is recommended by this report should be the agency having the authority and duty to pass on the sufficiency of plats presented for recording in aid of land descriptions. To do this adequately would probably require the bureau to have not only office personnel but a skeleton field organization as well, in order to make it possible in all cases to determine whether the plat or description presented is adequate. This means expense, but it is to be hoped that eventually the reasonable fees that could be attached to the operation of filing could take care of it. As has been emphasized, this sort of supervision cannot be immediately placed in effect on a large scale. It must be introduced gradually, if at all. Hence, it seems necessary that some means be found whereby the work, if it is to be attempted, can be taken care of for a time either in an existing state department, or by a small state-supported organization. Anything of this sort will not be easily or quickly accomplished, but it seems to me that just now the discussion should be on the question of its desirability. If the scheme proposed, or some modification of it, is thought desirable, then the difficulty of bringing it into effect should not prevent the effort to do so.

Highway Embankments Across TVA Reservoirs

FROM A PAPER PRESENTED BEFORE THE HIGHWAY DIVISION AT THE 1939 SPRING MEETING

By F. E. JUNIOR

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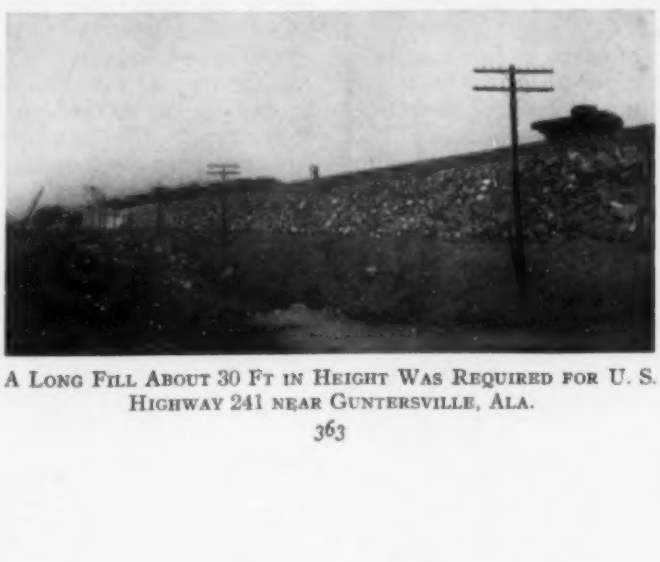
HIGHWAY embankments along or across large bodies of water require special care in design and construction if permanence is to be assured. Portions of such fills are submerged at all times, or at frequent intervals, and hence the stability of the material to be used and the efficacy of the protection from wave action become elements of prime importance.

Many fills in such exposed locations are included in the highway relocation program of the Tennessee Valley Authority, and because of the large total expenditure involved in their construction, the economy and suitability of various design types have been carefully studied. As a result, appreciable savings in cost have been made possible.

The Norris and Wheeler reservoir areas were the first scene of road relocation activities. On these projects the highway embankments were of two general designs, determined largely by the type of materials at hand. At Norris there was a large amount of rock available from roadway cuts. Therefore, the majority of the reservoir crossings on that project were constructed of rock for their entire width, from the natural ground level to a minimum elevation of 6 ft above normal pool level. Some of the roadway cuts did not provide sufficient rock for this type of construction and in these sections earth was used for the central portion of the embankment and the rock was placed on the outside. In the Wheeler Reservoir area the supply of rock was not sufficient for this type of design. Here an earth embankment was used, with slopes of 1 on 3 protected by a 4-in. layer of bank-run gravel and 10 in. of riprap. The earth was placed in 12-in. layers in accordance with general highway specifications.

Design studies for other reservoirs indicated that a further analysis would be required to determine methods for reducing settlement caused by saturation of the fills. Furthermore, it was realized that the crossings on these projects would be considerably longer and higher than those at Norris and Wheeler. Rock sufficient for the entire width of the fill and to cover the flat slopes would be expensive. High embankments of earth with rock on the outside did not appear sufficiently stable without proper consolidation. To assist in determining the proper design procedure, detailed cost estimates were prepared for numerous reservoir crossings, using different kinds of wave protection. A comparison of these estimates, taking into consideration the length and depth of the crossing, indicated that the principal controlling factors are the quantity and availability of embankment material.



A LONG FILL ABOUT 30 FT IN HEIGHT WAS REQUIRED FOR U. S. HIGHWAY 241 NEAR GUNTERSVILLE, ALA.

Slopes of 1 on 8 protected with 12 in. of gravel on the portion under the pool, and grass from that point to the shoulder, are desirable where large amounts of material are required. The quantity of earth determines to a considerable degree the use of this slope because it has a direct bearing on the type of hauling equipment to be used, which in turn controls the unit costs. Embankments of this type can be constructed economically up to a height of 16 ft or possibly higher when the earth is hauled short distances and the gravel is close by. Nearness to a good supply of rock will also be one of the deciding factors in the use of this design. Safety is an important element in its favor, since the flat slopes are safer for vehicles that run off the shoulder and also they increase the distance to the water's edge, thus eliminating the need for guard rail, except at structures.

Other designs to be considered have slopes varying from 1 on 2 to 1 on 3, with revetment consisting of 6 in. of gravel and 10 in. of riprap. The stability of the earth usually determines the use of such slopes. Economy in the cross-section of high fills is obtained by breaking the slope at the points permitted by analysis.

ROLLED FILL EMBANKMENTS WITH ROCK REVETMENT PROVE ECONOMICAL

Embankments that have generally proved cheapest to construct are those designed as shown in Fig. 1, with a compacted earth core having slopes of 1 on $1^1/_2$. Revetment consists of a layer of rock 4 ft thick measured perpendicular to the slope, extending from the natural ground level to an elevation $1^1/_2$ ft from the top. Riprap is placed from this elevation to the shoulder. As the rock fill is constructed perpendicular to the slope, sufficient depth is allowed for the installation of guard rail. Originally, 6 ft of rock was used to provide a working width for construction equipment, but experience has shown this to be more than necessary. Where a large amount of rock is available, this design is used on flat slopes because it requires less hand labor than riprap, and is therefore cheaper.

Some variation is made in each design for a reservior crossing and particularly in those having portions of the fill below the maximum drawdown pool. Under these conditions, no protection is placed from the natural ground level to an elevation 5 ft below drawdown, but this portion of the fill is made no steeper than 1 on $2^1/_2$. The reason for using a flat slope is to provide additional material in case there should be erosion after construction or while

the reservoir is being filled. Once the pool has risen to the level of maximum drawdown there is no further danger. This method of construction sometimes saves as much as one-half the total amount of revetment placed.

The general design slopes having been determined, the work on all projects is approached in a similar manner. The necessity for taking samples of the soil is decided from preliminary design of the embankment at the time the location is approved. Samples are omitted for fills 10 ft or less in height and for those having very flat slopes, because field selection of the soil for these conditions is satisfactory. An earth auger is used to obtain the necessary samples, except in special cases such as an existing embankment that will become a part of the completed work. These require a soil sampler that will remove the material in an undisturbed condition.

Preliminary design data, such as plan, profile, and typical cross-section, are forwarded with the samples and location records to the Authority's Soils Mechanics Laboratory for analysis and recommendation. Test results of each sample, with corresponding safe fill heights and slopes, are submitted by the laboratory in a detailed report. Determination of safe heights and slopes is based on the Swedish and Taylor methods of computation for capillary saturation and sudden drawdown conditions. Final design of the embankment is prepared from the data submitted in the report, due consideration being given to the type of wave protection economically suited to the slope suggested.

METHODS OF CONSTRUCTION

Control of construction to obtain the design requirements for embankments with rock-fill protection through reservoirs is outlined in the following paragraphs. Much of the information is applicable to other types of fills as well.

The earth core, or central portion of the embankment, is constructed in layers with a maximum thickness of 6 in. Maintenance of the water content within the limits of the design is important in order that maximum compaction be obtained. The compaction equipment used is a sheepsfoot roller weighing not less than 1,000 lb per lin ft of tread, or vehicles weighing not less than 8 tons loaded and operated so that their tracks are distributed uniformly over the entire layer. As considerable difficulty is experienced in obtaining compaction at the edges of the fills, the sheepsfoot rollers are always used along the shoulders, allowing them to extend beyond the edge as far as practicable.

Adjacent to structures where the usual construction equipment cannot be used, compaction is obtained by hand tamping. Moisture control and placement of the material in uniform layers is the same as for the remainder of the embankment. The tampers weigh at least 15 lb and have a tamping face of not more than 10 sq in.

Rock fill for the protection of earth embankments is constructed of material consisting of at least 85 per cent rock. It must all pass a 3-ft square opening and 20 to 75 per cent of it must pass a 1-ft square opening. This general graduation assists in obtaining a reasonably compact mass consistent with the kind of stone available; the smaller stones fill the voids between the larger ones and the fine material fills the smaller voids. Care in selecting the material to make sure that it is properly graded is essential, for planes of weakness may develop if earth is present in such quantity as to prevent sufficient contact between the rock surfaces.

The rock is placed in layers which are consolidated by hauling each truck load of material over the layer under construction a distance of at least 100 ft. This minimum distance is specified to insure longitudinal movement of the equipment over each layer, thus requiring the full load to be applied. The thickness of the layers is determined by the size of the largest stones and is not permitted to be greater than 4 ft. When the material is dumped from the edge of the earth fill, it is spread with a bulldozer.

Usually in constructing embankments with rock-fill protection, the placement of earth and rock proceed together. First the earth layer is built up to the thickness of the rock layer to be placed; then the rock layer is constructed up to the level of the earth. This permits the hauling and spreading equipment to assist in obtaining a good bond between the earth core and the rock fill. In placing the earth layer, caution should be exercised to prevent the earth from sloughing onto the rock layer below, thus forming ridges and seams that would destroy the bond. To further insure proper bond between the earth core and the rock fill, each layer is saturated with water at the junction of the two materials.

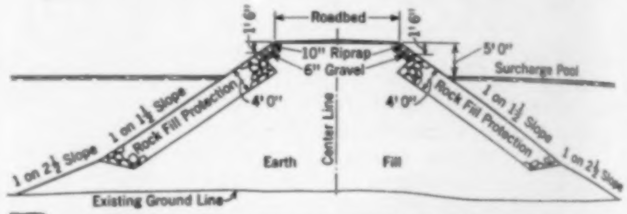


FIG. 1. TYPICAL EMBANKMENT WITH ROCK-FILL PROTECTION

Regular inspection is made during the construction of these embankments to make sure that the desired results are being obtained. Particular attention is given to the water content and the thickness of the layers in the earth core. This is especially important when fills are being constructed to their maximum allowable height. Samples of completed portions of the fill are taken, and their dry density is determined and compared with that designed. Whenever this density fails to meet design requirements, the material is removed and again compacted. The necessity for greater care in placing material in the shoulders is indicated by the fact that tests of this portion of the fill show less compaction than the remainder, sometimes by as much as 10 per cent. However, this compaction is maintained equal to or greater than that designed.

Embankments constructed in the manner indicated have met the requirements of design very satisfactorily. The compaction obtained has been equal to or greater than that designed, even around structures, where hand tamping is used.

Use of the method of design and construction described herein has been easily justified by the results obtained. The small increase in unit cost due to the use of relatively large quantities of rock and to the care taken in compaction, is negligible in comparison with the saving made by using steeper slopes, thus reducing the amount of fill required. This becomes a large item when the embankments are long and high. In addition, the cost of maintenance is greatly reduced; there is no settlement of the fill below the minimum elevation stipulated in the contracts, and the rock fill, being much thicker than other types of revetment, gives added protection from the action of waves. However, it is essential that the earth and rock be placed in accordance with a rigid specification to ensure stability, because portions of all these fills are submerged at all times or at frequent intervals.

ENGINEERS' NOTEBOOK

This department, designed to contain ingenious suggestions and practical data from engineers both young and old, should prove helpful in the solution of many troublesome problems. Reprints of the complete department, 8½ by 11 in., suitable for binding in loose-leaf style, are available each month at 15 cents a copy.

The Nomograph as an Aid in Computing Backwater Curves

By I. H. Steinberg
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In computing backwater curves by the rating curve, or Grimm method, it has been found that a nomograph can be constructed readily from the observed rating curves, which will eliminate the necessity of making several trial solutions in order to obtain the correct value of the open-river or natural discharge. A nomograph of this kind will be particularly useful where frequent computations are to be made over the same stretch of river.

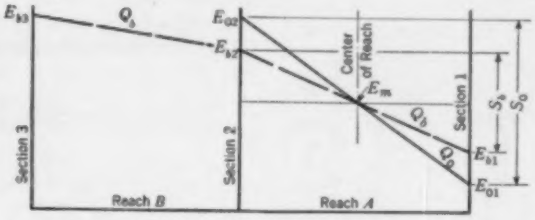

Fig. 1. Nomenclature

Referring to Fig. 1, E_{01}, Q_0, and S_0 are respectively the elevation, discharge, and fall for the open-river conditions, and E_{b1}, Q_b, and S_b are the corresponding values for the backwater conditions at Section 1 for Reach *A*. With Q_b and E_{b1} being known, it is required to determine the elevation E_{b2} at Section 2.

In the Chezy formula $Q = AC\sqrt{R\frac{S}{L}}$, where Q is the discharge, A the area, R the hydraulic radius, L the length of the reach, S the total fall, and C a constant. (All linear dimensions are in feet.) From this equation,

$$Q_0 = A_0 C \sqrt{R_0 \frac{S_0}{L}} \quad [1]$$

$$\text{and } Q_b = A_b C \sqrt{R_b \frac{S_b}{L}} \quad [2]$$

In the computation of flow lines, the hydraulic elements are ordinarily considered as being a function of the midpoint elevation of each reach. Thus, if the flow lines for Q_0 and Q_b pass through the same midpoint of Reach *A*, we can place $A_0 = A_b$ and $R_0 = R_b$. The value of C is assumed to remain constant. Then, dividing Eq. 2 by Eq. 1 and solving for S_b,

$$S_b = \left(\frac{Q_b}{Q_0}\right)^2 \times S_0 \quad [3]$$

In computing the backwater curve from Section 1 to Section 2, or upstream,

$$E_m = E_0 + \frac{S_0}{2} = E_b + \frac{S_b}{2} \quad [4]$$

Substituting the value of S_b from Eq. 3 in Eq. 4 there results,

$$E_0 + \frac{S_0}{2} = E_b + Q_b^2 \frac{S_0}{2\,Q_0^2} \quad [5]$$

Since E_0 and S_0 are dependent upon the value of Q_0, we can write $E_0 + \frac{S_0}{2}$ as $f_1(Q_0)$ and $\frac{Q_0^2}{S_0}$ as $f_2(Q_0)$.

Substituting these functions in Eq. 5, multiplying both sides of the equation by $f_2(Q_0)$, and replacing $f_1(Q_0)f_2(Q_0)$ by $f_3(Q_0)$,

$$f_3(Q_0) = E_b f_2(Q_0) + Q_b^2 \quad [6]$$

Equation 6 is a type form of equation for a nomograph represented by two parallel straight lines and a curve, similar to that presented in Fig. 2.

For computing a backwater curve from Section 2 to Section 1, or downstream, Eq. 4 becomes

$$E_m = E_0 - \frac{S_0}{2} = E_b - \frac{S_b}{2} \quad [7]$$

and upon reducing to the type form, becomes

$$F_3(Q_0) = E_b f_2(Q_0) - Q_b^2 \quad [8]$$

which results in a nomograph similar to that shown in Fig. 3.

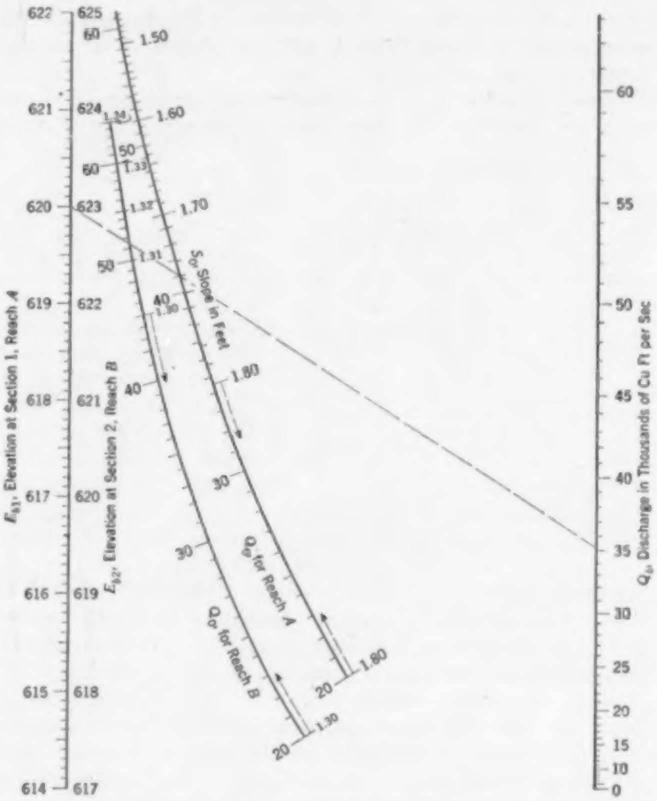

Fig. 2. Typical Nomograph for Backwater Computations (For Computing Upstream)

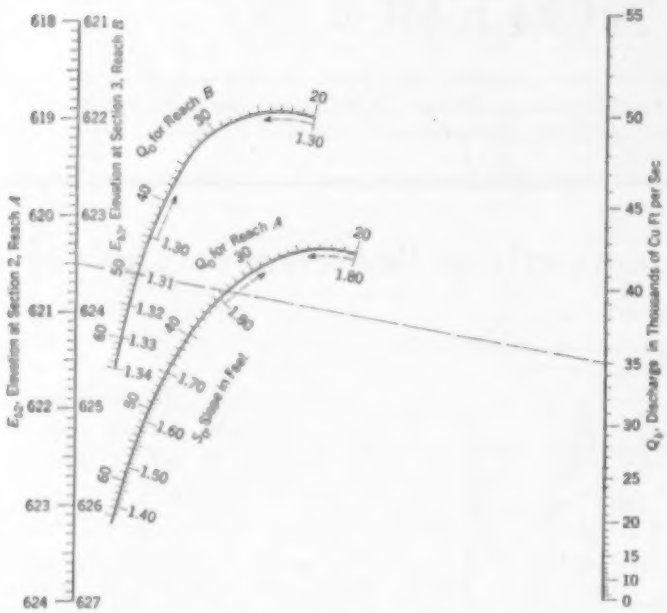

FIG. 3. TYPICAL NOMOGRAPH FOR BACKWATER COMPUTATIONS (For Computing Downstream)

The relation between the variables in Eqs. 6 and 8 is rather complex, and any attempt at an algebraic solution requires several trial computations. However, these solutions are not necessary because the nomograph can be constructed graphically from quantities which are readily determined from the known open-river rating curves (Fig. 4).

Scales for the two variables, E_b and Q_b, are first constructed on two parallel straight lines drawn any convenient distance apart. The fact that E_b in Eq. 6 is of the first power, indicates that the divisions on the E_b scale will be uniform; and since Q_b is of the second power, the divisions for Q_b will be proportional to the square of the discharge.

The Q_0 scale is then constructed graphically from points determined by the intersection of a pair of lines

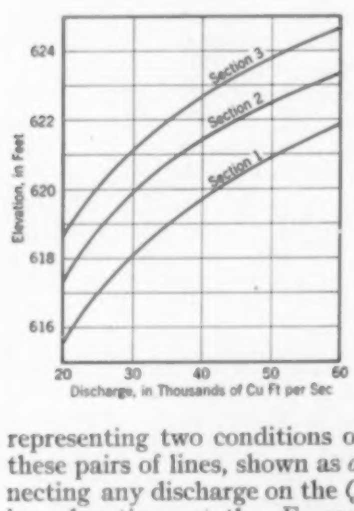

FIG. 4. OPEN-RIVER RATING CURVES (BASIC DATA FOR NOMOGRAPHS)

representing two conditions of Q_0. The first of each of these pairs of lines, shown as a in Fig. 5, is drawn by connecting any discharge on the Q_b scale with its corresponding elevation on the E_b scale, as obtained from the known open-river rating curves. The midpoint elevation for this discharge is then determined. Since for zero discharge the elevation at the end of the reach will be the same as that at the midpoint, the line connecting this elevation on the E_b scale with zero on the Q_b scale, shown as b in Fig. 5, will intersect a at a point on the Q_0 curve. After a sufficient number of points have been established in this manner, the Q_b curve is constructed by drawing a smooth curve through these points.

Divisions for the Q_0 scale are then determined from the intersection of this curve with lines drawn through a discharge on the Q_b scale and its corresponding elevation on the E_b scale, as previously explained.

The S_0 scale is constructed by plotting opposite each discharge on the Q_0 scale the difference in elevation, in feet, between the upper and lower ends of the reach for that discharge.

Example 1 (computing upstream): it is desired to compute the backwater curve for a flow of Q_b equal to 35,000 cu ft per sec for Reaches A and B, with the elevation E_{b1} at Section 1 equal to 620.00.

The straight line drawn on Fig. 2 through the given values of E_{b1} and Q_b will intersect the curve for Reach A at the desired values of Q_0 = 40,900 cu ft per sec, and S_0 = 1.74 ft.

Substituting these values in Eq. 3, $S_0 = \left(\frac{35{,}000}{40{,}900}\right)^2 \times 174 = 1.28$. Therefore, the elevation E_{b2} at Section 2 is 620 + 1.28, or 621.28. Similarly, for Reach B, with E_{b2} = 621.28 and Q_b = 35,000 cu ft per sec, the values of Q_0 = 38.4 and S_0 = 1.30 are obtained from the curve for Reach B, from which S_b = 1.08. Then E_3 = 621.28 + 1.08 = 622.36.

Example 2 (computing downstream): Given the elevation E_{b3} = 623.5 at Section 3, and Q_b = 35,000, use the nomograph for the downstream computations (Fig. 3) which will give Q_0 = 50.2, and S_0 = 1.31, from which S_b = 0.64, and E_{b2} = 623.5 − 0.64 = 622.86. For

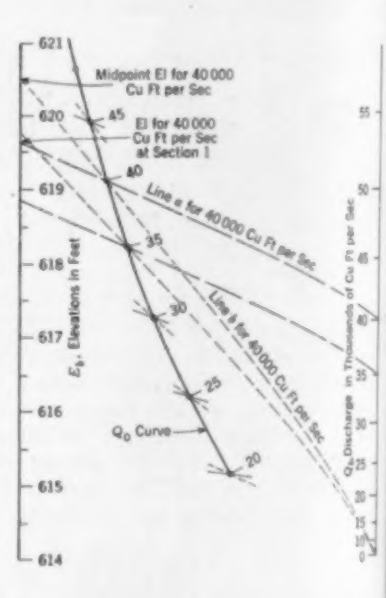

FIG. 5. METHOD OF CONSTRUCTING NOMOGRAPH

Reach A, Q_0 = 59.8 and S_0 = 1.52, which gives S_b = 0.52 and E_{b1} = 622.86 − 0.52 = 622.34.

In analyzing the nomograph for downstream computations (Fig. 3), it is evident that for some combinations of E_b and Q_b the line connecting these values will not intersect the curve at any point, and therefore there can be no solution. For other combinations of E_b and Q_b two points of intersection are possible, which would tend to indicate that there are apparently two possible solutions. However, in attempting to compute the flow line for the adjacent downstream reach, it will be found impossible to obtain a solution.

From this it may be concluded that for every discharge there is a corresponding minimum elevation below which a flow line for that discharge cannot exist.

Friction in Hydraulic Models

By THOMAS DEF. ROGERS

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HYDRAULIC models are frequently built to investigate phenomena other than friction, for which, nevertheless, a knowledge of the effect of friction is essential. Common practice has been to use the Manning formula, in which the friction parameter, n, is supposedly constant for any given surface. The inapplicability of this relationship, as pointed out by Herbert D. Vogel, M. Am. Soc. C.E., and J. P. Dean ("Geometric Verus Hydraulic Similitude," CIVIL ENGINEERING for August 1932), is due to the fact that except for conditions of fully developed turbulence, n is not actually a constant but varies with the slope and the hydraulic radius. Furthermore it is known that the shape of the flow cross-section also influences its value.

An investigation of the effect of roughness in open channels, conducted at the University of California by the author, indicates the manner of this variation and suggests another method of evaluating friction losses in models—a method which, having a rational theoretical background, is probably more reliable. The object of this investigation was the extension of the modern theory of turbulence to open channels. A triangular channel, 70 ft in length, was used in the tests. Two degrees of absolute roughness were investigated: (1) that of a smooth varnished surface, and (2) that obtained by

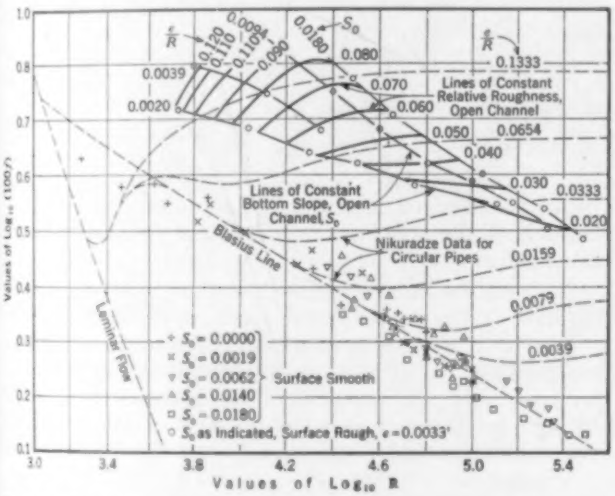

FIG. 1. FRICTION COEFFICIENT (OPEN CHANNELS) PLOTTED AGAINST REYNOLDS NUMBER

All Plotted Points Are from Author's Experiments

attaching sand grains, the mean diameter of which was determined from a sieve analysis for use in computing the relative roughness. For each combination of bottom slope, discharge, and surface used, the Weisbach pipe friction coefficient f, Reynolds number R, and the relative roughness e/R, where determined and plotted as shown in Fig. 1. A precision analysis indicates that the probable error in the results is due largely to the probable error in the instrument measurements.

One of the conclusions of the investigation is that friction in a hydraulically smooth conduit is governed by the equation $1/\sqrt{f} = 2 \log (\mathbf{R}\sqrt{f}) - 0.8$, an equation having a rational derivation (see "Turbulence and Skin Friction," Theodor von Kármán, M. Am. Soc. C.E., *Journal of the Aeronautical Sciences*, January 1934), regardless of the geometry of the flow cross-section. For all practical purposes this equation agrees with the Blasius law, $f = 0.316/R^{1/4}$, over the range of conditions encountered in hydraulic models. By comparing the Blasius and Manning formulas the following expression for Manning's n for smooth surfaces may be derived:

$$n = \frac{0.148R^{1/24}\nu^{1/8}}{gV^{1/8}} \qquad [1]$$

in which ν represents the kinematic viscosity and V the mean velocity.

Captain Vogel, assuming that n has the same value in the prototype as in the model, and that the hydraulic radius may be represented by the depth, has derived the following model law:

$$q = l^{1/2}d^{13/6} \qquad [2]$$

in which q represents the ratio of discharge in the model to that in the prototype, l the ratio of horizontal distances, and d the ratio of depths. By a similar analysis, but using Eq. 1 to express n, there results the following model law:

$$q = l^{3/7}d^{16/7} \qquad [3]$$

Table I compares the values of q resulting from this law, those resulting from the two laws derived by Captain Vogel, and those resulting from actual measurements.

TABLE I. COMPARISON OF THEORETICAL AND ACTUAL DISCHARGES

Model Characteristics: Surface	l	d	$q = l^{3/7}d^{16/7}$ (From Blasius Equation)	$q = l^{1/2}d^{13/6}$ (From Manning Equation)	$q = ld^{3/2}$ (From Froude's Law)	Measured q
Concrete:						
A	1:4,800	1:360	1:26,000,000	1:24,000,000	1:32,800,000	1:21,000,000
B	1:4,800	1:200	1:6,900,000	1:6,700,000	1:13,600,000	1:7,200,000
C	1:2,400	1:120	1:1,585,000	1:1,567,000	1:3,155,000	1:1,570,000
D	1:1,200	1:48	1:145,000	1:152,000	1:399,000	1:150,000
Sand Bed:						
E	1:720	1:72	1:291,000	1:284,000	1:440,000	1:300,000
F	1:720	1:72	1:291,000	1:284,000	1:440,000	1:280,000

The data for the comparison are taken from Captain Vogel's paper. It will be noted that good general agreement is obtained using either Eq. 2 or Eq. 3. Even better agreement, however, may be expected using the Blasius relationship (as in Eq. 1), if in the derivation of a model law the actual widths and depths, and consequently the ratio of the hydraulic radii, are known.

It should be remembered that the above discussion applies only to hydraulically smooth surfaces. For rough surfaces the investigation indicated that even with fully developed turbulence, Manning's n varies not only as the one-sixth power of the roughness projections but also in some manner with the geometry of both the roughness and the flow cross-section. It may be concluded, then, that unless the law governing this variation is known, geometric distortion of hydraulic models is advisable only for hydraulically smooth conduits if friction forces are of importance.

Spacing of Stirrups in Reinforced Concrete Beams

By WILLIAM J. LARKIN, JR., M. AM. SOC. C.E.
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MANY designers see no need of following any exact method of determining the full gamut of spacings for stirrups in reinforced concrete beams. To save time they simply compute the required spacing at a few points along the beam (often only at the support) and are then able, from past experience or by reference to tables of typical spacings, to arrive at an acceptable arrangement. In general, designs so made are not inadequate. In particular cases, however, especially as the number of stirrups increases, they may become questionable.

To follow a practice of completely determining the correct spacings, as an advisable step in the proportioning of stirrups, need not entail a deterrent amount of work. The procedure described here obtains results by an operation hardly more extended than the computation of a single spacing by the usual method. It is based on the usual design assumptions and basic formulas as given in the paragraphs on diagonal tension and shear in the 1937 Progress Report of the Joint Committee.

Beams under uniform load will be considered first. Let

N = the total number of stirrups for one end of the beam
a = the length of the "steel stress shear triangle"—that is, the shear diagram minus the area representing the amount of stress assumed to be carried by the concrete
x = the ordinal number of any stirrup counting from the apex end
y = the distance to that stirrup from the apex
s = the spacing between that stirrup and the next stirrup, number $x + 1$

Now, given the steel stress shear triangle indicated in Fig. 1 (for which a = 60 in.), let it be required to determine the spacings for 5 stirrups.

The vertical lines, full and dotted, divide the triangle into 10 equal-area portions, the dotted lines representing the positions of the stirrups. It can be shown that the lines parallel to one side of a triangle, that divide the triangle into any desired number of equal parts, are at distances from the apex that are proportional to the square roots of the successive integers. Thus the distances to the full lines are proportional to the square roots of successive even integers, and the distances to the stirrups are proportional to the square roots of successive odd integers. The encircled numbers in Fig. 1 are values of x. The symbol L is used in lieu of y for distances other than those to the stirrups. From Fig. 1 it is evident that $K = 60/\sqrt{10}$, or, in general, that

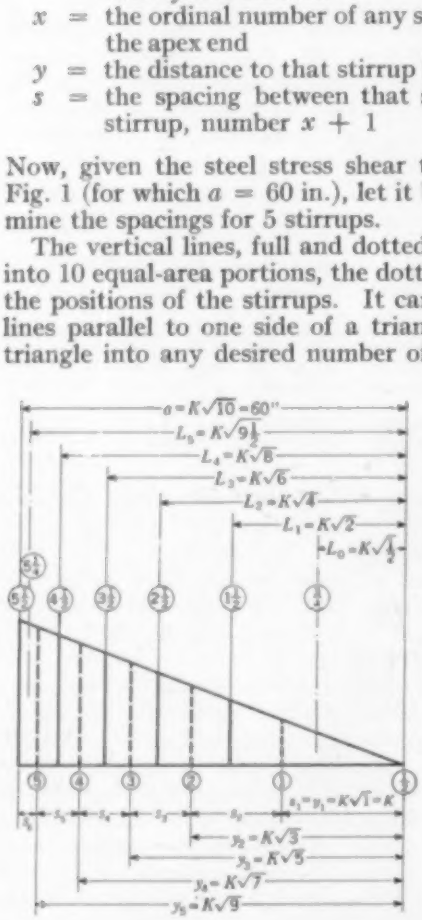

FIG. 1. STEEL STRESS SHEAR TRIANGLE, WITH NOMENCLATURE

$$K = \frac{a}{\sqrt{2N}} \qquad [1]$$

$$y = K\sqrt{2x - 1} \qquad [2]$$

$$s_1 = y_1 = K \qquad [3]$$

To provide for comparisons with the approximate results to be obtained later, the illustrative problem may first be solved by using Eq. 2, which gives mathematically correct values. This solution is given in Table I, in the form of listings of the slide-rule settings and readings. The advantage of using the slide rule is obvious.

In Table I we were obliged to record the slide-rule readings and then go through a series of subtractions to obtain the desired spacings. The following derivation shows how the spacings may be read directly from the slide rule.

TABLE I. SOLUTION OF ILLUSTRATIVE PROBLEM BY MEANS OF EQ. 2

Slide-Rule Computations		Exact Computations
	Differences or Spacings	
Setting 10 on Scale B at 60.0" on Scale D = a		
	3.1" = s_6	3.079"
Opposite 9 on Scale B is 56.9" on Scale D = y_5		
	6.7" = s_5	6.721"
Opposite 7 on Scale B is 50.2" on Scale D = y_4		
	7.8" = s_4	7.774"
Opposite 5 on Scale B is 42.4" on Scale D = y_3		
	9.6" = s_3	9.563"
Opposite 3 on Scale B is 32.8" on Scale D = y_2		
	13.8" = s_2	13.889"
Opposite 1 on Scale B is 19.0" on Scale D = y_1		
	19.0" = s_1	18.974"

The first derivative of Eq. 2 is $f'(x) = K/\sqrt{2x - 1}$. The law of the mean states that, in the interval from $x = a$ to $x = b$ of a continuous function, there is an intermediate value of x, say x_1 such that $f(b) - f(a) = f'(x_1)\,(b - a)$. In the case of Eq. 2 the spacings of the stirrups are the increments of that function for successive unit increments of the variable x. Therefore, $(b - a) = 1$ and $s = f'(x_1) = K/\sqrt{2x_1 - 1}$. For the function with which we are dealing, the mathematically correct values of x_1 do not bear a simple relation to the known factors. However, we can use the mid-values of x instead of the true values of x_1 and obtain results sufficiently accurate for all practical purposes. Letting x_m be the mid-value of x in each interval, we shall assume that the following equation is essentially correct:

$$s = \frac{K}{\sqrt{2x_m - 1}} \qquad [4]$$

Solving Eq. 2 for $y = 0$ gives $x = 1/2$ at the apex of the triangle. Solving for $y = a$ and for $K = a/\sqrt{2N}$ gives $x = N + 1/2$ at the support. In the case of Fig. 1, therefore, we have the following series of values:

x =	$1/2$	1	2	3	4	5	$5^1/_2$
x_m =		$3/4$	$1^1/_2$	$2^1/_2$	$3^1/_2$	$4^1/_2$	$5^1/_4$
$2x_m - 1$ =		$1/2$	2	4	6	8	$9^1/_2$

The increments of x in the first and last intervals are $^1/_2$ instead of 1. In the statement of the law of the mean, therefore, the factor $(b - a)$ becomes $^1/_2$, and as a result we have for the terminal spacings,

$$s_t = \frac{1}{2}\frac{K}{\sqrt{2x_m - 1}} \qquad \text{[5]}$$

The listing of the slide-rule computations for the solution of the illustrative problem by means of Eqs. 4 and 5 is given in Table II, the readings, of course, being made

TABLE II. SOLUTION OF ILLUSTRATIVE PROBLEM BY MEANS OF EQS. 4 AND 5

Slide-Rule Computations	Exact Computations	Error
Setting 10 on Scale B at 60.0" on Scale D		
Opposite $9^1/_2$ on Scale A is 6.2" on Scale I by $^1/_2$ = 3.1" = s_6	3.078"	0.001"
Opposite 8 on Scale A is 6.7" on Scale I by 1 = 6.7" = s_5	6.708"	0.013"
Opposite 6 on Scale A is 7.7" on Scale I by 1 = 7.7" = s_4	7.746"	0.028"
Opposite 4 on Scale A is 9.5" on Scale I by 1 = 9.5" = s_3	9.487"	0.076"
Opposite 2 on Scale A is 13.4" on Scale I by 1 = 13.4" = s_2	13.416"	0.473"
Opposite $^1/_2$ on Scale A is 26.8" on Scale I by $^1/_2$ = 13.4" = s_1	13.416"	5.558"

on the inverse scale. The final column of figures gives the differences between the exact computations of Table I and those of Table II.

The values in the last column of Table II are the errors that result from using the approximate Eqs. 4 and 5 in this particular example. These errors, however, would run in the same ratio to each other in any problem. The only error that is of any significance is that in s_1, but this distance is y_1 and, as was noted in Eq. 3, is equal to K. The value of K, by the setting of the slide rule, is on Scale D opposite 1 on Scale C and is also on Scale I opposite 1 on Scale A. Hence we need not apply Eq. 5, with its resulting error, to determine s_1. In practice, the first reading may be made from $2N$, or 10 in this case, instead of $9^1/_2$.

The solution of a stirrup-spacing problem can then be generalized as follows: Let N be the total number of stirrups to be spaced in a, the length of the steel stress shear triangle. Set the slide with $2N$ on Scale B opposite a on Scale D. Set the runner on $2N$ on Scale A and take one-half of the reading on the inverse Scale I to give the distance from the face of the support to the adjacent stirrup. Move the runner down the series of even numbers on Scale A and read the succeeding spacings in turn on Scale I. The final spacing is read on Scale I opposite 1 on Scale A. Add stirrups, as may be required at the apex end to conform to maximum permissible spacing requirements.

From the foregoing discussion another relation may be derived which provides an alternate procedure. If we multiply both the numerator and the denominator of Eq. 4 by $\sqrt{2x_m - 1}$ we have $s = \dfrac{K\sqrt{2x_m - 1}}{2x_m - 1}$. By Eq. 2 the expression $K\sqrt{2x_m - 1}$ gives the values of y to the intermediate dividing lines between the stirrups, the full lines of Fig. 1. For these distances L has been substituted for y to avoid confusion. Obviously $2x_m - 1$ is equivalent to $2x$. Therefore $s = L/2x$. A more indicative notation results if we use the symbol n instead of x, or

$$s = \frac{L}{2n} \qquad \text{[6]}$$

For any value of n, L is the distance from the apex to the intermediate dividing line beyond stirrup n. If $n = N$, then $L = a$, and letting S be the full spacing at the support (the distance from stirrup No. 5 to an assumed stirrup No. 6) we would have

$$S = \frac{a}{2N} \qquad \text{[7]}$$

Equation 6 may be applied to definite advantage in the case of beams under concentrated loads, and may be used in any case in preference to the method first explained. An approximately correct procedure is to determine each value of L from the preceding value of L by deducting the last computed value of s. The use of this method for the solution of the illustrative problem is given in the left-hand half of Table III. The tabulations are more detailed than necessary, the calculations having been carried to one decimal place solely to permit of comparisons with the previous solutions. In actual practice the next higher whole numbers would suffice, and the process would stop when the maximum permissible spacing was reached. In the right-hand half of the table, included for purposes of comparison, are the true values of L, from Eq. 2, and the resulting values of s, from Eq. 6.

It is evident from Table III that, whatever the difference is between the approximate value of L and the exact value, the difference between the corresponding values of s is much less owing to the division by $2n$. The error increases as we approach the apex but is negligible until the spacings s_2 and s_1 are reached. Usually the maximum permissible spacing will govern before these last two calculations would have to be made.

The following would serve as a formal statement of the alternate approximate procedure: Let N be the total number of stirrups to be spaced in a, the length of the steel stress shear triangle. The full spacing at the support is $a/2N$, or S. The distance from the support to the adjacent stirrup is $S/2$ or s_a; the next spacing is s_b, or $\dfrac{a - S}{2(N-1)}$; the next, s_c or $\dfrac{(a - S) - s_b}{2(N-2)}$; and so on, continuing up to the maxmum permissible spacing.

TABLE III. SOLUTIONS OF ILLUSTRATIVE PROBLEM BY MEANS OF EQ. 6

From Approximate Values of L				From Exact Values of L			
a .... = 60.0"	$2N = 10$	$S = 6.0$"	$s_6 = 3.0$"	$L_5 = K\sqrt{9^1/_2} = 58.5$"	$2n = 9^1/_2$	$2s_6 = 6.2$"	$s_6 = 3.1$"
$L_4 = 60.0" - 6.0" = 54.0"$	$2n = 8$	....	$s_5 = 6.7$"	$L_4 = K\sqrt{8} = 53.7$"	$2n = 8$	....	$s_5 = 6.7$"
$L_3 = 54.0" - 6.7" = 47.3"$	$2n = 6$	....	$s_4 = 7.9$"	$L_3 = K\sqrt{6} = 46.5$"	$2n = 6$	....	$s_4 = 7.7$"
$L_2 = 47.3" - 7.9" = 39.4"$	$2n = 4$	....	$s_3 = 9.8$"	$L_2 = K\sqrt{4} = 38.0$"	$2n = 4$	....	$s_3 = 9.5$"
$L_1 = 39.4" - 9.8" = 29.6"$	$2n = 2$	....	$s_2 = 14.8$"	$L_1 = K\sqrt{2} = 26.8$"	$2n = 2$	....	$s_2 = 13.4$"
$L_0 = 29.6" - 14.8" = 14.8"$	....	....	$s_1 = 14.8$"	$L_0 = K\sqrt{^1/_2} = 13.4$"	$2n = {}^1/_2$	$2s_1 = 26.8$"	$s_1 = 13.4$"

Beams under concentrated loads can be handled in exactly the same manner as beams under uniform load. In this case the steel stress shear diagram is a trapezoid, but the non-parallel sides can be extended to intersect and thus form a triangular figure. N then becomes the total number of stirrups that would be required in the full triangle. It can of course be computed by dividing the area of this triangle by the "stirrup value."

Except in rare instances N will not be integral. In so far as practical accuracy of results is concerned, the nearest integral number may be used. It may be noted, however, that the actual value of N, as determined in any problem, could be used to determine the mathematically correct positioning of the stirrups, since Eq. 2 is a continuous function and x may have any value and still define a distance y from the apex. The simplest solution is to solve Eq. 7 for both ends of the trapezoid, after which the intermediate spacings are determined by inspection.

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

An Ancient English Bridge

To the Editor: In the "Autobiography of George H. Pegram," in the April issue, there appears some material relating to New York's elevated railroads together with a hazarded opinion that, "These structures are today (1933) probably the oldest metal structures, in point of service, in the world." The same article includes a photograph of a portion of the Sixth Avenue Elevated, 1879–1939, now being razed, and the caption refers to it as a "venerable structure."

Limiting our survey to bridges alone, which are still in service today (1939), there are in England alone a number of major engineering works which outrank the New York elevated railroads in point of time. Incidentally, they may be considered as bridges for purposes of comparison.

The Chepstow Bridge, over the Wye River, contains 5 spans in cast iron, the center span being 112 ft; it was opened in 1816, and still carries main highway traffic. The Saltash Bridge, near Plymouth, contains two main spans of 455 ft each, suspended from single elliptical tube girders, all in wrought iron. The spans also incorporate eye-bar suspension. This bridge was designed by the famous Brunel, was opened in 1859, and today still carries the heaviest express trains.

Another well-known bridge is the Clifton Suspension Bridge over the Avon River near Bristol. It is of eye-bar construction, has a span of 702 ft, was opened in 1864, and is still carrying heavy road traffic. The Menai Straits Bridge, designed by Telford, first president of the Institution of Civil Engineers, was opened in 1826. It is also of eye-bar design, and has a span of 580 ft. It has been strengthened in recent years, which modifies its claim to continuous service.

But the claims of all these structures—and there are others—to be regarded as venerable must be retired gracefully before that of the patriarch of metal bridges, whose photograph appears on the Page of Special Interest in this issue (reproduced through the courtesy of the Director, the Science Museum, South Kensington, London). This structure, the Coalbrookdale Bridge, which spans the River Severn near Brosely in Shropshire, was designed, cast, and erected by one Abraham Darby, a local ironmaster, in 1779, and was therefore already a century old when the Sixth Avenue line was built. Without structural alteration or renewal, it still functions as a highway toll bridge, one of the very few remaining in England. With the exception of a few minor parts it is of cast iron throughout; its five ribs are cast in sections, with all fastenings made with cotters and keys, and give the bridges a fairly well-proportioned appearance.

Its span is 100 ft 6 in., with a rise of 40 ft 0 in. at the center above the springing line. Undoubtedly it owes much of its long life to the original abutments still soundly based on good rock, which have stoutly resisted all floods over its long and honorable career of 160 years.

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Economical Planning of Hydroelectric Plants

Dear Sir: The fact that my paper on "Initial Investigations and Economical Planning of Hydroelectric Plants," in the December issue, has prompted discussion has been of great satisfaction to me. In his letter in the February issue, Robert A. Monroe made a particular point of comprehensive regional planning with the multi-purpose development of sites and the incidental use of the power developed. He also pointed out that the developments of the larger river systems must necessarily be undertaken by governmental agencies. In the writer's opinion, the development of power under the conditions mentioned by Mr. Monroe, in which it is considered "incidental—even though it may carry the major part of the cost of a multi-purpose project"—does not present an engineering problem involving economic considerations, but rather must be viewed from a sociological or political standpoint.

As a result of observation of some of the multi-purpose structures built to date, the writer is unable to subscribe to Mr. Monroe's idea that, "It will be possible to utilize some but not all of the flood storage capacity to impound water for low-water regulation of power after the danger of floods has passed." Any encroachment upon the capacity of a reservoir reserved for flood storage for power purposes involves taking extremely dangerous risks as Nature frequently refuses to follow established standards or precedent.

In the same issue, Professor Barrow pointed out that in designing and building hydroelectric stations the cost of equivalent steam stations must be given very serious consideration—also, that the engineer should not overload his system with extensive storage capacity on the headwaters until he has assured himself of its economy. The writer subscribes very heartily to these two principles.

From the letter of Philip Sporn, in the March issue, it is evident that he and his organization have a complete understanding of the necessity of sound economic planning in connection with hydroelectric work. Mr. Sporn pointed out that after such a study has been made, to interpret the result requires the combined ideas and efforts of specialists in the organization with a broad background of experience in power system design and operation. This point was brought out by the writer in the original paper but, unfortunately, in abstracting these papers it is not always possible to retain the desired emphasis.

Mr. Sporn has indicated that obsolescence, long-term commitments, and questions of national economy should be considered in evaluating a proposed hydro development against a steam plant and because of the uncertainty of these, hydro power must cost less than the equivalent steam in order to be justified. These points are worthy of careful thought, but the writer believes there are also other points that may favor the hydro development. For example, uncertainties are always present in the costs of fuel for steam plants because of unpredictable trends of labor and transportation. The principal point, however, is that a careful comparison and analysis must be made of all the many elements entering into the picture, and each case decided upon its respective merits.

Mr. Sporn has also called attention to the rate of system load growth, pointing out that it is a very exceptional property that can show a load growth in excess of 5 per cent. This statement is very true, and the predicted peak-load growth shown in Fig. 1 is only a trend curve and, due to changing economic conditions, the actual load in any year may depart very materially from this line. In my article I indicated that by 1938 the load should have a peaking demand of approximately 123,000 kw, and in checking back through the records, in response to Mr. Sporn's inquiry, it was actually found that the peak load was 121,000 kw.

One of the principal reasons for presenting this paper was to focus the attention of engineers on the economic problem which must be satisfactorily solved before any commitments have been made. It is the writer's hope that in coming meetings of the Society, other engineers will discuss this question fully and in its broadest aspects.

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New York, N.Y.

Urban Zoning Problems

To the Editor: When Mr. Orton, in his article in the April issue, says that, "One of the great sources of loss in our growing American cities has been their instability," he understates the fact.

Ever since Colonial days our whole program of growth has been predicated upon constant change. We have counted upon the ever-rising tide of population growth to offset depreciation in buildings due either to neighborhood changes or to physical deterioration. In other words, we have believed it unnecessary to amortize

investments in urban buildings, confident that rising land prices would always offset depreciation and permit future sale of the site for more than the original cost of site and building.

This has happened often enough to make many believe that in these dynamic cities fundamental economic laws did not hold good. But recent decline in population growth from causes too numerous to mention brings us face to face with reality. By subdividing and selling urban land far in advance of need, by investing public money in street and subsurface improvements which lie unused, by investing private funds in a great excess of business structures, and by building generally for quick resale profits rather than for permanent yield, we have been wasteful.

So long as the supply of purchasers held out there were profits, but the decline in population growth and the effects of the depression have suddenly aroused us to the fact that our real estate speculation has paralleled the stock market crash of 1929. There is no longer a rush of eager and undiscriminating buyers for all properties. Just as in purchasing securities people are now considering the fundamental elements of security and yield when they invest in urban real estate.

Mr. Orton points out that it is improper to criticize the framers of the early New York City zoning ordinance because it has proved less than perfect. The pioneers who forged this new weapon were at first unable to reverse the mistaken beliefs of a century about urban building. To a large extent there still exists the fallacious belief in unlimited future growth of our urban centers, but shrewd real estate men and planners know that this is not the case. They realize that readjustment is necessary until sales prices and assessed valuations bear a reasonable relationship to true values and that true values, in turn, depend upon security and permanent yield. Too many who cry that there must be "relief of real estate" really would like governmental action guaranteeing that their properties would not be less than the speculative prices they once paid for them. But wise citizens and planners know that the government can no more guarantee against bad judgment in the purchase of real estate than it can guarantee the permanence of speculative prices in a stock market boom.

The financial health of the community demands a realistic approach to this problem, and that can be made only in terms of planning and rezoning. As land prices in a falling market tend to approximate true values and as speculative losses are liquidated, we will get back to a condition where private capital can afford to make investments for permanent yield.

Unfortunately the zoning ordinances of New York and many other cities, drawn in a period when the philosophy of unlimited growth prevailed, permitted building bulks vastly in excess of those which we now know to be sound, as Mr. Orton so aptly points out. They zoned for business use much more area than the population can support, not only in New York but in almost every other municipality that has employed zoning. They likewise made provision for a great excess of population in multi-family districts. Instances without end could be cited.

Salvation will come through a revision of our zoning ordinances based upon comprehensive municipal plans, involving the readjustment of the urban pattern so as to fix the areas to be allotted to business, industry, multi-family houses, and dwellings in relation to the reasonable needs of a future stabilized population. It will come when we realize that urban land is entrusted to us to be used for the benefit of our citizens rather than for speculation.

WAYNE D. HEYDECKER
Director of State Planning, State of New York

Albany, N.Y.

Discrepancies in Fixed Beam Solutions Explained

IN the April issue was published the closing discussion of the paper by Odd Albert, Assoc. M. Am. Soc. C.E., on "The Fixed Point Theory for Fixed Beams with Elastic Supports." This closure pointed out certain apparent errors in a previous discussion by Ralph W. Stewart, M. Am. Soc. C.E., who solved one of the examples by a different method. Actually, the method used by Mr. Stewart should have produced the same results as that used by Professor Albert. The error was caused by Mr. Stewart's having used the circled numerals in Professor Albert's Fig. 5 (in the December issue) as stiffness factors—a natural misunderstanding. These numerals, however, were simply identification numbers for the various beams and columns, all of which had the same moment of inertia.—*Editor.*

Investigations of Air Entrainment

DEAR SIR: In the February issue Professor Lane has pointed out that the entrainment of air in swiftly-flowing water is a factor of importance in the design of hydraulic structures. It is especially important to note that investigations of air entrainment must be made on full-sized structures, as Professor Lane has done. Since the phenomenon depends upon the absolute values of velocity, depth, and so forth, it cannot be studied in that otherwise useful tool of the designer—the small-scale model. This limitation of the small-scale model is revealed by the accompanying photographs.

These photographs present a view of flow in a spillway, together with a comparative view of corresponding flow in a model of the spillway to the scale, model-to-prototype, of 1 to 20. The spillway is the overflow structure for the reservoir at the U. S. Waterways Experiment Station. It will be noted from inspection of the photographs that the model accurately reproduced the conditions obtaining in the prototype with the exception of the entrainment of air in the water.

EUGENE P. FORTSON, JR., Jun. Am. Soc. C.E.
Assistant Engineer, U. S. Waterways Experiment Station

Vicksburg, Miss.

AIR ENTRAINMENT DIFFERENTIATES PROTOTYPE FROM ITS MODEL

In Comparing Similar Views in Prototype (Left) and Model Spillway (Right) the Prototype Is Distinguished by the Presence of White Water

Permeability and Shear Test Results

DEAR SIR: I was very much interested in the article, "Field Control of Compacted Earth Fill," by Howard F. Peckworth in the April issue.

Mr. Peckworth's idea of determining the required density in a dam embankment from the permeability and shear test results (adjusted with the proper factor of safety) is very interesting and gives a logical result. However, I wonder whether this method will not give us a false sense of accuracy and security due to the lack of reliability of these tests and to the present lack of knowledge of the correlation between test results and actual field conditions.

Practically every soil laboratory has a different-sized shear-testing machine and a procedure of its own for running the test. This variety of machines and procedures gives different results for the same soil, depending on what laboratory is making the test. In addition to that, the values of cohesion and angle of internal friction thus obtained have not been correlated to the actual conditions existing in an embankment.

Although the permeability test is not in such a state of chaos, it nevertheless has many factors that introduce a degree of variation larger than would be warranted in careful laboratory work. The question of correlation of laboratory test results with the permeability of the same material rolled in an embankment is also a large unknown.

Are we then justified in basing density requirements on these test results?

The oil method of determining the density of the fill is very interesting. The writer has always used the sand method which is accurate to within about $1^1/_2$ per cent. It would be interesting to know what the accuracy of the oil method is.

Mr. Peckworth suggests a method of determining moisture content in the field by drying in an open tin plate over a coal fire. It is known that some slight dehydration of the water in clay occurs even below the boiling point. To dry a sample in ten minutes, as proposed, would necessitate temperatures much above the boiling point, naturally causing more dehydration. Would this not introduce a larger error than could be allowed in fill-control work?

The objections to the penetration needle advanced in Mr. Peckworth's paper are well taken from a theoretical standpoint. However, the writer's experience has shown him that they do not seem to make much difference in practice when the needle is used for moisture control only, and not for density control. While in charge of soil testing and fill control on Ralston Dam, built by the Board of Water Commissioners of Denver, Colo., I had the opportunity to check up on this phase of fill control on about two and a quarter million cubic yards of controlled embankment. Moisture was checked on incoming borrow material, using the penetration needle in conjunction with a light aluminum field Proctor cylinder, and a moisture-penetration resistance curve (for the particular area being excavated) furnished by the laboratory. The necessary water, allowing for evaporation loss, was then added, and later the density was checked by digging a hole and filling it with calibrated sand. In addition to his regular moisture tests, each inspector was asked to send one check sample in an airtight can to the laboratory, each shift. This sample was oven dried, to find the agreement or discrepancy between oven drying and the value of moisture the inspector had determined with his needle. These data were collected for a period of approximately sixteen months of three shifts daily, and the agreement was very satisfactory. A great deal of the time the discrepancy was under one per cent of moisture, most of the time under two per cent, and only occasionally as much as three or four per cent. Most of the large discrepancies—which occurred usually on night shifts—were traced to the shovels having moved into different material. The average control range on the material used in the clay core was 6 to 7 per cent, occasionally narrowing down to 4 per cent, so that the needle control was well within the range. The type of material will determine whether this can be obtained, of course, or whether Mr. Peckworth's objections to the penetration needle will govern.

E. A. ABDUN-NUR, Assoc. M. Am. Soc. C.E.
Assistant Engineer, Indian Division,
Civilian Conservation Corps

Billings, Mont.

Need for New Understanding of Economics

TO THE EDITOR: I have just read Mr. Doherty's article on "The Paradox of Social Progress," in the March issue, and am pleased to note that professional publications have begun to take an interest in economic conditions. At critical times, such as these, the consideration of means to improve social and economic conditions should be a paramount concern of all professional publications.

Mr. Doherty's article indicates that the main hope of solving the problem of correlating social and economic well being with technological production lies in the direction of education. No one will criticize this point of view. If all professions acted in accordance with it, some little influence might be brought to bear on the powers that control education. Within the past sixty years technological education has advanced several hundred per cent, and in just about the same proportion knowledge of social and economic conditions has retrogressed.

We should look into the cause of this paradox and, if possible, combat it with the right kind of education. Sixty years ago the teaching of economics to technological students was not considered necessary. Then the majority of those in charge of public affairs and of teaching our youth had come from environments in which there was a close relationship with the producer. The fundamental principles of production and equitable distribution were known to nearly everyone. Since that time there has been a change from the original idea of creating wealth, to the idea of getting something for nothing. Then everyone thought in terms of doing and having "things." Now almost everyone thinks only in terms of "money" and "high prices."

People no longer understand that high prices mean low consumption, which may affect purchasing power. Sixty years ago the law of supply and demand was thought to be good for the majority. Today a suggestion of preserving this law would expose the advocate to tar-and-feather treatment.

This change in sentiment has been brought about by the fact that our technological education has had the paramount objective of making the student a financial success. Teaching has become a big business, with the principal object of inspiring the young to equal or outstrip those in public view who have succeeded—irrespective of how they succeeded. Any solution of this problem should begin with primary education and progress upward.

Unfortunately, those guiding our ship of state do not have their ears open to the few who could help the ship on a forward course. Rather, they are listening to those giving the most votes.

Competent people can accomplish little lecturing to each other. The forces to reckon with are the vote controllers who now have get-something-for-nothing ideas. Such people are not interested in tomorrow but will vote for any promise of something for today.

Technologists should be thankful to the scientists who have put so many things on a mathematical basis. In the field of science order has superseded disorder. However, social and economic arguments are still disordered. The reason is that we have advanced no further in developing economic principles than to describe human actions and reactions in terms of production and distribution.

Under every form of government we find the principles underlying prosperity to be substantially expressed in the formula, $E = IPD$, where E is prosperity, I is incentive, P is production, and D is distribution. If we would occasionally think in terms of groups of, say, twelve people instead of thinking always in the complicated terms of many millions of people, we could see how $E = IPD$ might represent either unlimited prosperity or the opposite, depending on the cooperation of the twelve people.

To try to get the political consciousness of the average voter back where it was sixty years ago, the writer has worked for several years to obtain a hearing on a system of teaching the simple principles of economics, beginning in the kindergarten. This teaching would consist of entertainment in making and exchanging things, and in conducting business, such as would show children how they could prosper without limit or how they could become poor without limit. It should soon impress them with the idea that prosperity is composed of "things," rather than "money."

Thus far, however, the writer has found that public interest in any undertaking to better our economic status is nil.

GUY B. WAITE, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.

SOCIETY AFFAIRS

Official and Semi-Official

San Francisco Prepares for Annual Convention

Society to Convene on West Coast, July 26–29, 1939

The Sixty-Ninth Annual Convention of the Society, to be held in San Francisco on July 26–29, 1939, offers a double threat to existing attendance records. In the first place, the program planners have seen to it that nine of the Society's twelve Divisions are on the schedule—so that whether a member's interest be in irrigation, city planning, soil mechanics, hydraulics, dams, bridges, highways, or sewage treatment plants, he is bound to find something in his own field in the technical sessions. And in the second place, the program committee offers, as an added attraction, the Golden Gate International Exposition. Convention activities have been so arranged as to take full advantage of its facilities and exhibits.

Here is the program in brief—general meeting, technical sessions, social events, and excursions. Complete details will be published in the July issue.

Wednesday, July 26, 1939

Morning

Addresses of Welcome
Response
Annual Address of the President
Business Meeting

Afternoon

Technical Division Sessions

Joint Session—Irrigation and Hydraulics Divisions
Hydraulics of Sprinkling Systems for Irrigation
Silt Problems of the Imperial Irrigation District Resulting from the Completion of the Boulder Dam
Design of Curves for High-Velocity Open Channels

Waterways Division
Protecting Chicago's Water Supply
Chicago River Controlling Works
The Central Valley Project

Soil Mechanics and Foundations Division—Session I
Photoelastic Analysis of Stress in Earth Masses
Sealing the Clay Lining of the Lagoon at Treasure Island by the Use of Sea Water
Report of Committee on Earth Dams and Embankments

Thursday, July 27, 1939

Morning

Technical Division Sessions:

Soil Mechanics and Foundations Divisions—Session II
Effect of Earthquake Motion on Foundations
The Fort Peck Slide—Explorations and Reconstruction
The Fort Peck Slide—Tests and Analyses

The Great Highway and Esplanade at San Francisco

Irrigation Division
Report on Division Activities and Committee Work
The Water Supply for Irrigation of the Central Valley Project
Permissible Quality of Irrigation Water
Concrete Linings for Irrigation Canals

Structural Division (General Subject—Earthquake Resistant Design)
Progress in Earthquake Resistant Design
Provisions for Seismic Forces in the Design of the San Francisco–Oakland Bay Bridge
Provision for Seismic Forces in the Design of the Golden Gate Bridge
Shaking-Table Tests on High Bridge Piers

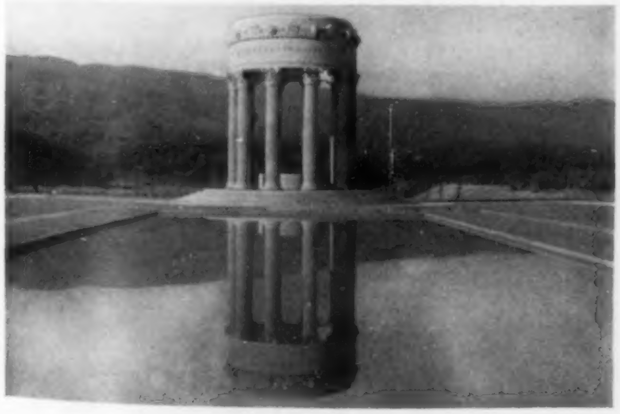
Luncheon at Treasure Island

Afternoon

Demonstration in Hall of Science of shaking tables and other exhibits of particular interest to structural engineers, as well as other exhibition attractions

Evening

Dinner and Entertainment on Exhibition Grounds



The Pulgas Water Temple, Peninsula Terminal of the Aqueduct from the Sierra Nevada

Upper San Leandro Filter Plant of the East Bay Municipal Utility District

Scenes on the Route of an Inspection Trip at the Annual Convention

FRIDAY, JULY 28, 1939

Morning

Technical Division Sessions

Hydraulics Division

Practical Uses of the Flow and Pressure Nets in Hydraulic Investigations

Cross-Drainage Floods and a Railroad

Sanitary Engineering Division

Technical and Esthetic Aspects of Watershed and Impounding Reservoir Sanitation

Experiences in the Operation of the Chemical Treatment Plant of the Minneapolis–St. Paul Sanitary District

History and Operation of the Sanitary Fill Method of Disposal of the Mixed Municipal Refuse of San Francisco

Water Supply System of San Francisco

Richmond–Sunset Sewage Treatment Plant and Other Sewage Disposal Improvements

Symposium on Masonry Dams—under auspices of Power, Construction, Irrigation, Soil Mechanics and Foundations, Structural, and Waterways Divisions (Sessions I and II of the Symposium were held at the 1939 Spring Meeting in Chattanooga)

Session III

Geology of Dam Sites

Concrete Control

Construction Joints

Afternoon

Technical Sessions

Symposium on Masonry Dams (*Continued*)

Session IV

Testing of Dams, Dam Models, and Spillways

Part I. Structural Testing

Part II. Hydraulic Testing

Determination of Stress by the Use of Indirect, and Mathematical Methods

Tendencies in Design and Construction of Masonry Dams

Joint Session—City Planning and Highway Divisions

Roadside Control Through Zoning

Metropolitan Highway Problems

Financial and Physical Planning

Sanitary Engineering Division Excursion

SOCIAL FEATURES AND ENTERTAINMENT FOR LADIES

WEDNESDAY, JULY 26, 1939

Afternoon

Ladies' Trip about San Francisco with Tea at the Legion of Honor Building overlooking the Golden Gate.

Evening

Dinner and Dance at the Hotel St. Francis.

THURSDAY JULY 27, 1939

Luncheon and Dinner at the California Building on the grounds of the Golden Gate International Exposition, with the afternoon occupied in seeing the sights of the fair.

Special entertainment will be provided and the day will be celebrated as "Civil Engineers' Day" at the exposition.

FRIDAY, JULY 28, 1939

Morning and Afternoon

Ladies will be taken on a trip down the Peninsula, with luncheon at Stanford University. In the afternoon, the ladies will be entertained at an organ recital at the Stanford University Chapel.

MEETINGS AT TWO WORLD'S FAIRS

ATTENTION is called to the fact that just six weeks after the Annual Convention, in San Francisco, the 1939 Fall Meeting will be held in New York. This scheduling permits members who wish to attend both meetings and both World's Fairs to take advantage of the "Grand Circle" rates now being offered for rail travel.

"Grand Circle" tickets, good for two months, provide transportation from any point in the United States to San Francisco, thence to New York, "and thence to the point of beginning," for as little as $90 (coach fare). Any number of stopovers, and any combination of routes, can be arranged.

The Fall Meeting (September 4–9) is a joint enterprise of the Society, the Engineering Institute of Canada, and the Institution of Civil Engineers (London), and a large attendance from Canada and Great Britain is anticipated.

Two excursions are being planned for members and men guests on Friday afternoon. One excursion is of special interest to sanitary engineers, and will cover the sanitary aspects of the San Francisco Water Department. The second excursion for men will include an inspection of the Bay bridges.

The local committee in charge of arrangements is headed by George Wesley Pracy, while the technical program is being planned under the chairmanship of Dean Samuel Morris. The complete personnel of all committees will appear in the final program in the July issue.

SPECIAL TOUR FOR EASTERN MEMBERS TO SAN FRANCISCO

As customary with the western meetings, arrangements have been made for group travel for members from the eastern states. Leaving New York and southern points on July 16, the party will assemble at Chicago the following day. There will be a similar rendezvous at Omaha for those from the Middle West. On July 19 the party will detrain at Truckee, Nev., and motor to Lake Tahoe. The following three days the motor tour will continue—to Minden and Mono Lake; via Tioga Pass, Tuolumne Meadows, and Aspen Valley to Yosemite Valley; and thence to Glacier Point and via Badger Pass to San Francisco. July 23–25 will thus be free in San Francisco before the opening of the Convention. The return trip can be adjusted to suit individual members.

Further details of this tour can be secured from Society Headquarters or from Leon V. Arnold, travel consultant, 36 Washington Square West, New York, N.Y. The cost is unusually reasonable, and special rates are also available for those wishing to visit both San Francisco and New York within a two-month period.

Meeting of Board of Direction—Secretary's Abstract, April 17–18, 1939

ON APRIL 17 and 18, 1939, the Board of Direction met at the Hotel Patten in Chattanooga, Tenn., with President D. H. Sawyer in the chair, and Secretary Seabury and the following members of the Board in attendance: Past-President Mead, Vice-Presidents Noyes, Pirnie, Reppert, and Ferebee; and Directors Agg, Anderson, Bres, Brooks, Davis, Dean, DeBerard, Harrington, Leeds, Legaré, Lewis, Needles, Root, Sawin, Shea, and Stanton.

Regrets at inability to attend were received from Messrs. Ayres, Hudson, Riggs, and Tiffany.

President's Comments

This being the first regular gathering of the Board following its organization meeting, the President addressed the Board on its problems and possibilities. He mentioned various ways in which he believed the Board could best serve its primary function, to give "direction" to the Society's affairs and service to its members.

Approval of Minutes

Minutes of the Outgoing Board Meeting, January 16, and 17, and of the Incoming Board, January 19, 1939, were approved. Minutes of the Executive Committee of January 14 and 19, 1939, were approved and the actions therein were adopted as the actions of the Board.

Local Section Constitutions Revised

As requested by the Cincinnati, Kansas State, Pittsburgh, and Tacoma Sections, approval was given to the revision of their constitution in minor detail.

Election of Officers

As provided in the By-Laws, it was in order to appoint certain Society officers. The present incumbents were unanimously re-

appointed as follows: Secretary, George T. Seabury; Treasurer, Otis E. Hovey; and Assistant Treasurer, Ralph R. Rumery.

Amendments to By-Laws re Divisions

In line with the new arrangement and procedure of Division work, changes were adopted in the By-Laws covering such features, in accordance with regular procedure. These changes relate to Article IV, Section 10, and Article VIII, Sections 1, 2, and 3. Minor alterations were made in the wording, to bring these sections into accord with the series of revisions covering administration of Divisions, as outlined in the May issue, page 321; that is, to provide for Functional Divisions. In this category are to be included the Construction, the Surveying and Mapping, and the Engineering Economics Divisions.

Schedule of Society Meetings

Approving the recommendation of the Technical Procedure Committee, the following schedule of Society meetings for 1940 was adopted:

Spring Meeting—Kansas City, Mo.
Summer Convention—Denver, Colo.
Fall Meeting—Cincinnati, Ohio

A committee of Board members was appointed to determine meeting places for 1941.

Construction-Engineering Prize

Following recommendation from the Executive Committee, the Board approved establishment of a Construction-Engineering Prize, as offered by A. P. Greensfelder, M. Am. Soc. C.E. The objectives and specifications for this prize are given in detail in an adjoining item.

Committees Report

Various committees of the Board reported on matters under their jurisdiction, mostly covering routine matters of Society work.

Membership

The Board listened in detail to reports from its Committee on Membership Qualifications, covering a large number of cases of applications for membership. Extended study was accorded to all these matters, before Board vote in each instance.

Juniors

Report was received from the Committee on Juniors and was extensively discussed. The Board ordered that it be distributed to Local Sections and published in CIVIL ENGINEERING (see page 376).

Routine Matters

Other miscellaneous matters were presented to the Board and were accorded appropriate action in each case.

Adjournment

The Board adjourned to meet in San Francisco, Calif., on July 24, 1939.

New Construction-Engineering Prize Is Offered

THROUGH the initiative and generosity of A. P. Greensfelder, M. Am. Soc. C.E., of St. Louis, the Society has been able to add one more to its list of annual prizes for technical contributions to its publications. With approval by the Board of Direction of Mr. Greensfelder's suggestion covering the character and administration of this prize, as considered at the Board's Chattanooga Meeting on April 17, the Construction-Engineering Prize assumed official status.

The approved rules and procedure governing the award of this prize are as follows:

"Competition for the Construction-Engineering Prize shall be restricted to members of the Society in any grade.

"The prize shall consist of $50.00 in cash with an appropriate Certificate signed by the President and the Secretary of the Society.

"The prize may be awarded annually to the author, or joint authors, of the best original scientific or educational paper on construction, presented to or printed by the Society in CIVIL ENGINEERING during the specified annual period. The matter may have been presented initially before the Society or its Construction Division; and shall not have been previously published.

"The paper shall deal with a construction-engineering project in the United States or its possessions, with which the author was directly connected as either an officer or a construction engineer for the general contractor responsible for the construction of such project or as a field superintendent directly responsible for its completion. The presentation shall accentuate the ingenuity and efficiency of the field methods adopted, unit cost-time data, the engineering basis for advanced construction practice, the application of new or unusual methods, or other technical achievements in the performance of the work.

"Only papers printed during the twelve months ending with the July issue of the year of the award shall be eligible for consideration. In judging papers published in abridged form, due weight shall be given to the original complete manuscripts.

"The award shall be made on recommendation of the Executive Committee of the Construction Division and subsequent approval by the Board of Direction of the Society.

"Recommendation to the Board for the yearly award shall be filed with the Secretary of the Society in writing not later than October 1 of that year. The public presentation of the prize shall be made at the Annual Meeting immediately following."

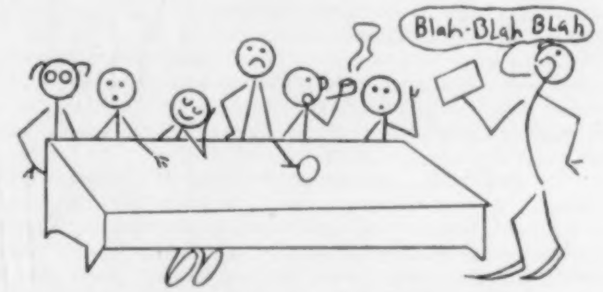
Publicity Program Progresses Through Participation of Local Sections

DURING the past year special emphasis has been placed on a phase of the Society's publicity program not previously stressed to any great extent—namely, publicity through the medium of men selected by the Local Sections to handle press releases in their own communities. This "decentralization" has made possible personal contacts with editors and reporters in all parts of the country, thus adding a personal touch that a single publicity director located at Society Headquarters could never hope to achieve.

The plan has been effective beyond expectations. Fifty-one Sections to date have appointed chairmen to keep the public informed through the press of the activities of their Local Sections, and the results have been excellent. These chairmen report Section meetings, the subjects discussed, and the projects visited, and arrange for interviews with the prominent people who address the meetings. Thus a new vista is opened up to the public at large of the scope of work of the civil engineer and the value of this work to the community. This concentrated effort should have a measurable effect upon the status of the civil engineer in society.

SPRING MEETING EFFECTIVELY PUBLICIZED

An outstanding example of a well-publicized engineering event is the recent Spring Meeting in Chattanooga. The publicity committee of the Chattanooga Sub-Section was ably assisted on this occasion by Mrs. John F. Barksdale, whose husband is Area Engineer, TVA, and an Associate Member of the Society, and it is chiefly due to her efforts that the publicity total was so great.



PICTORIAL RECORD OF MARCH MEETING OF KNOXVILLE SUB-SECTION, TENNESSEE VALLEY SECTION, BY AN ANONYMOUS ARTIST

Publicity for the meeting was sent out by her to 23 regional newspapers on an average of every other day, and local news to 3 daily papers in Chattanooga every day, for about three weeks before the event. Scattered news stories and pictures were supplied to local papers for an even longer period. By this means, all records

for Spring Meeting publicity totals were broken; the 259 clippings received measured up to 2,555 column inches, or 905 column inches more than any previous Spring Meeting of the Society. These clippings were distributed over 50 cities, 21 states, and the District of Columbia.

Publicity serves another function as well, inasmuch as it stimulates the members' interest in meetings and gives them first-hand knowledge of the activities of their Section and of local civil engineering news. This type of publicity—"internal publicity"—is achieved within each Local Section by monthly notices or bulletins. These bulletins, more numerous of late, are written in various veins, ranging from the serious and technical to the light, informal type. Particularly novel is one which comes from the Knoxville Sub-Section of the Tennessee Valley Section. Their March meeting is reported to Section members thus:

"The March meeting, in which the Professional Objectives Committee tried to conduct an orderly discussion of the status of the engineer, turned out to be one of the most spirited of the year. Everyone present wanted to talk at the same time and it nearly turned into a riot until George Tomlison saved the day by moving for adjournment. Many excellent points were brought out. Among them was a plea by the Juniors to try to find out where they stand. Also, the Honorable Mayor of the City was rebuked for neglecting to appoint an engineer to the Utility Board.

"Seventy members and guests were present.

"Jim Goddard reports that 139 out of 178 of the members of this Sub-Section have paid their dues. That is pretty good but Jim wants a perfect record. Send him your Buck."

Other Sections that are doing excellent jobs in the way of internal publicity are Cleveland, Georgia, Los Angeles, Michigan, Philadelphia, Rochester, Sacramento, San Francisco, Seattle, Texas, and the Chattanooga Sub-Section.

From Society Headquarters a little informal leaflet, "Headlines," is being mailed each month to the local publicity chairmen to help them in their work. It serves as a sort of clearing house for publicity ideas originating in the various Sections; reports progress in the outstanding Sections, showing why this or that is good publicity; and points our errors that have been made—not in the news releases themselves, but in not making the most of opportunities for obtaining publicity.

Committee on Juniors Outlines Suggestions for Local Section Work

Progress Report as Presented to the Board of Direction, April 18, 1939

AS A RESULT of its discussions in Chattanooga, on April 17, 1939, the Committee on Juniors feels that the most pressing problem facing the Junior is to get employment, secure adequate compensation and advancement commensurate with the effort he is willing to put forth, and the committee recommends that immediate action to assist him to meet these needs be taken by the American Society of Civil Engineers.

We recommend the adoption of the suggestion in the 1938 Report of the Committee on Juniors that each Local Section appoint a Committee on Juniors where such a committee does not exist, and that the work of the committee be along the lines outlined below. We regard the formation of such local committees as the fundamental means of translating into action the recommendations of this committee. This is necessary in view of the fact that the problems confronting the Juniors are different in different localities and can best be met by men familiar with the specific local conditions. The problems are also, in many instances, personal in nature and can be met only by men charged with the responsibility of assisting Junior members and advancing their status.

The proposed objectives of the local Junior committees are as follows:

A. Work to Be Done with the Juniors

1. To establish as complete a record as possible of the employment, responsibilities, and opportunities for advancement of each Junior in the Section.
2. To encourage the Junior to accept every opportunity for professional advancement whether by graduate study, by preparing papers, by work in the Local Section, or otherwise.
3. To sponsor the formation of Junior branches or forums where the numbers are large enough to indicate that such forums could operate successfully. Where the numbers are too small, to encourage the employers of Juniors to organize study groups among them.
4. To see that the suggestion of the Board of Direction that there be a Junior on each committee of the Local Sections is carried out, and further to see that such Juniors report back to the Junior group the action of such committees so that the Juniors may be familiar with the work of the Sections, and especially that the Juniors may know of the interest of the corporate members in their development and advancement.

B. Work to Be Done with the Employers

1. To take such active steps as may be appropriate to the local situation to encourage all employers of young engineers to give preference to engineering graduates in subprofessional jobs.
2. To make sure that the engineer employer knows the American Society of Civil Engineers' ratings for such service.
3. To guard against subprofessional rates for work of a truly professional character. (The Committee feels that such low rates endanger the status of the whole profession and that the rates paid by the WPA and by many cities, counties, and states have offended in this regard.)
4. To urge the employer to give the Junior responsible charge of work so far as that may be possible so that the Junior can qualify for corporate membership and meet the requirements for state registration.

It is suggested that each local Junior committee work with the Committee on Professional Objectives and with the faculty sponsors and contact members of the Student Chapters in their district, that the members of the committees be aware of the work of the E.C.P.D. for Juniors, that where the Section is not affiliated with an employment agency it act as a clearing house for jobs.

It is also suggested that the local Junior committee take an active interest before local and state Civil Service boards, not only by assisting in writing specifications for men who will occupy engineering positions but also by having them accept only such engineers as are qualified by education to fill such positions, where they should function much more satisfactorily than non-technical men.

We realize that the success of this program will depend upon the personnel of such Junior committees, and therefore make the following suggestions regarding the makeup of these committees:

The chairman must be a man who has a keen interest in young men, who has the confidence of the Board of Directors of the Local Section, of the employers, and of the Juniors themselves. The second member might be a member of the local Committee on Professional Objectives, the third member the chairman of the local Student Chapter Committee, the fourth member the chairman of the Junior group, with at least one other Junior to back him up.

We make these definite suggestions because if this is to be successful the student members must be familiar with the setup, they must know that when they become Juniors there is someone to whom they may go to discuss their problems, someone who is familiar with their difficulties, and someone who has their interests at heart. There is no thought that the committee is to act as a guardian but rather that it bring home to the Junior the necessity of self-development, self-reliance, and self-discipline. The committee should impress upon the Junior that both he and they are members of an organization that stands ready to maintain and advance the status of the profession.

Respectfully submitted,

COMMITTEE ON JUNIORS

E. WARREN BOWDEN — T. R. AGG
A. C. POLK — S. B. LILLY, *Temporary Chairman*
W. M. SPANN, *representing Chairman Veatch*

Regional Student Conferences Held

Interesting Programs Presented at Spring Gatherings at Colleges

Since 1920, when the first Student Chapter was founded, there has been a marked increase of student interest in Society affairs. During the past ten years this interest has been intensified by the occasional conferences of Student Chapter representatives, held at the time of the Spring and Fall Meetings of the Society. A different type of student conference, at which neighboring Chapters get together year after year to conduct what is, in effect, almost a miniature Society meeting, was originated by the Philadelphia Section several years ago. Growing interest in and recognition of the usefulness of such conferences merit the attention of members of the Society as well as of students. Ten regional conferences of Student Chapters were held between April 15 and May 13 in various parts of the country. The following reports of these conferences have been received to date.

The Carolinas—April 14–15

In February 1939, representatives from the Student Chapters in North Carolina and South Carolina effected the union of the Chapters in the two states into a single regional conference. The first spring meeting of the new conference, which is the outgrowth of the North Carolina Student Conference of several years' standing, took place on April 14 and 15 at Clemson College, S. C. Representatives were present from the Chapters at Duke University, The Citadel, the University of South Carolina, Clemson College, and North Carolina State College. The conference officers responsible for the meeting were Chairman Lucas from the Duke University Chapter, and Secretary W. O. Buys of the North Carolina State College Chapter.

Student papers were presented in competition for prizes donated by the North Carolina and South Carolina Local Sections. First prize went to C. W. Ramsey, of Duke University, for a paper describing his work in photoelastic analysis. Other prizes were awarded to F. J. Knox, of Clemson College, for his paper on suspension bridges; S. G. Zynda, of The Citadel, for his paper on photoelasticity; and C. E. McCrorey, of the University of South Carolina, for a paper describing his work on the Santee Cooper Tailrace Canal at Pinopolis, S.C.

The principal address—on the Buzzard Roost hydroelectric project at Greenwood, S.C.—was given by Daniel T. Duncan, chief engineer of the Duncan Engineering Company.

Southeastern—April 20–21

Nineteen Student Chapters sent 138 representatives to Chattanooga, Tenn., at the time of the Spring Meeting of the Society, for the Southeastern Spring Conference of Student Chapters. The sessions thus took on the character of both a student conference at the time of a Society meeting and also a regional conference. Represntatives were present from the following Chapters:

Alabama Polytechnic Inst.	17	Ohio State Univ.	2
Alabama, Univ. of	10	South Carolina, Clemson, A. and M., College of	2
Armour Inst. of Technology	2	South Carolina, Univ. of	9
Citadel, The	6	Tennessee, Univ. of	15
Florida, Univ. of	6	Texas, A. and M., College of	10
Georgia School of Technology	6	Texas, Univ. of	1
Kentucky, Univ. of	16	Tulane Univ.	7
Louisiana State Univ.	3	Vanderbilt Univ.	17
Louisville, Univ. of	2	Virginia Military Inst.	7
North Carolina State College	1		

Detailed plans for the conference were made by the officers of the Chapters at the University of Tennessee and Vanderbilt University, members of the two Chapters having met at Vanderbilt last fall to inaugurate the program. Chapters in the vicinity were early advised that student papers would be presented and were invited to submit one or two of the papers from their own competitions.

Morning and afternoon sessions presided over by Regional Chairman Gerald Johnson, of Georgia School of Technology, were devoted to the presentation of 13 student papers. The committee of judges consisted of the following members of the Society: G. E. Tomlinson, chairman; L. F. Bellinger, former Vice-President of the Society; and A. C. Polk, Contact Member for the University of Alabama Student Chapter. As a result of the contest, J. R. Mooney, of Tulane University, received first prize, consisting of fifteen silver dollars, for his paper on "The Use of Asphalt Revetment in Mississippi River Control." The second prize of ten dollars went to Allen Jones, of the University of Tennessee, for his paper on photoelasticity. The papers were judged for skill in presentation as well as for technical content.

Between these two sessions Donald H. Sawyer, President of the Society, addressed a luncheon gathering of students and members, as did E. M. Hastings, member of the Committee on Student Chapters. Others who spoke were Past-Presidents Daniel W. Mead and A. N. Talbot, Director T. Keith Legaré, and A. H. Hope, Esq.

Special rates were provided for students attending the dinner dance in the evening, and a unique and highly successful "date bureau" established by the local committee provided charming partners for the visiting students.

On the following morning representatives from the Southeastern Conference Chapters held a three-hour business session, at which they decided to meet next spring in Alabama, elected conference officers, and discussed many topics of direct interest to the Chapters. The officers for next year are John Redmond (Alabama Polytechnic Institute), president; Norman Walton (Georgia School of Technology), vice-president; and Robert Morris (University of Alabama), secretary.

The conference was planned and executed completely by students. Throughout the discussions they placed great emphasis on the acquisition of a professional outlook by members of the Chapters prior to graduation so that graduates will be prepared to enter into Society activities upon achieving Junior membership. The Society is proud of the intelligent and substantial viewpoint evidenced by this group of young men.

Data for this report were supplied by John E. Womack, secretary of the Chapter at the University of Tennessee, and Ralph D. Beall (Georgia School of Technology), secretary of the Southeastern Conference.

Metropolitan—April 22

The annual Metropolitan Spring Conference of Student Chapters was held on Saturday, April 22, at Manhattan College, New York, N.Y., where the Manhattan College Chapter was host to 91 representatives from eight Student Chapters in the metropolitan area, together with 34 other guests. Brooklyn Polytechnic Institute sent 2 representatives; Columbia University, 4; Cooper Union, 14; Manhattan College, 34; College of the City of New York, 9; New York University, 11; Newark College, 14; and Rutgers University, 3.

The morning session was devoted to vocational guidance, the speakers being Alfred Hedefine, Woodman F. Scantlebury, and Alan Lee Slaton, all members of the Society. These young men described their experiences in professional practice, emphasizing those experiences that had not been anticipated from school training. Also, Frank A. Busse, instructor in civil engineering at Newark College of Engineering, spoke on how to conduct oneself in applying for a job and during the first stages of new employment. These talks aroused keen interest among the students about to graduate.

Following a luncheon at the college, the topic of the afternoon session, "Unionization," was introduced by Van Tuyl Boughton, managing editor of *Engineering News-Record*. "The Case for Unionization" was presented by Lewis Alan Berné, international president of the Federation of Architects, Engineers, Chemists, and Technicians, and "The Professional Engineer's Answer" was given by D. B. Steinman, consulting engineer of New York. A frank discussion followed these talks.

The conference aroused considerable enthusiasm and is rated a distinct success. Information for this report was furnished by Alan Lee Slaton, Junior Correspondent from the Metropolitan Section.

PHILADELPHIA—APRIL 24

Chapters in the area of the Philadelphia and Lehigh Valley Sections met at Bethlehem, Pa., on April 24 as guests of the Lehigh University Chapter. This is the oldest of the Regional Student Chapter Conferences and has been the inspiration for the even dozen of such groups that are now demonstrating their worth throughout the country. To the Philadelphia Section goes the credit for initiating and continuing the series.

Representatives were present from 11 Chapters, as follows:

Bucknell Univ.	1	Pennsylvania State College	17
Univ. of Delaware	21	Princeton Univ.	1
Drexel Inst. of Technology	19	Swarthmore College	10
Lafayette College	21	Univ. of Pennsylvania	8
Lehigh Univ.	26	Villanova College	9
Penn. Military College	6	Total	139

This is the largest meeting yet held in point of attendance.

The Philadelphia Section was represented by William E. A. Doherty, president; C. A. Howland, secretary; and Scott B. Lilly, chairman of the Section's Committee on Student Chapters.

The sessions were conducted by Robert B. Evans, president of the Lehigh University Chapter. Following an address of welcome by Dr. C. C. Williams, president of Lehigh University, there was a response by Mr. Doherty and an address by Professor Lilly.

Seven student papers were presented in competition for the three prizes awarded annually by the Philadelphia Section. First prize (consisting of the entrance fee and one year's dues as a Junior in the Society, plus $20 in cash) and second prize (the entrance fee and one year's dues as a Junior) were divided equally between Robert Somers, of Drexel Institute, and A. George Mallis, of Lafayette College, when a tie was declared for their two papers on "Riveted and Welded Rigid Frames" and "The Construction of an Inexpensive Photoelastic Apparatus," respectively. Third prize was awarded to John W. Roberts, of Swarthmore College, for his paper on "Unit Costs of Laying Concrete Pipe." The board of judges, all members of the Society, consisted of Howard T. Critchlow, Berthold F. Hastings, and William H. Jameson.

The representatives were guests of Lehigh University at luncheon following which the prizes were awarded. The afternoon session included an inspection of the university campus and buildings.

A feature worthy of note is that the regional Chapter conferences in this area are always held on a week-day, with the result that there is no competition with week-end attractions. The various colleges grant time off to the representatives who attend, with the result that the attendance is always good. A tradition of fine programs for these gatherings accounts for the enthusiasm of the participants.

Arrangements for the conference were made by the officers of the Lehigh University Chapter under the leadership of the president, Robert B. Evans. Data for this report were furnished by the faculty adviser, Prof. H. G. Payrow.

TEXAS—APRIL 29

For several years it has been the custom of the Chapter at the Agricultural and Mechanical College of Texas to send representatives to the Southeastern Regional Conference of Student Chapters. Nine such representatives attended the Chattanooga Meeting and were inspired to form a Texas Regional Student Chapter Conference, which was organized at the Corpus Christi meeting of the Texas Section on April 29. On this occasion, 35 representatives from the four Chapters in Texas were entertained at a student breakfast by the Texas Section, following which a Texas conference was set up. Under the temporary chairmanship of President Clytus Parris, of the Texas Technological College Student Chapter, representatives from Texas Technological College, the University of Texas, the Agricultural and Mechanical College of Texas, and Rice Institute joined in the discussions and election of the first group of officers for the conference. Hilton K. Davis, of the University of Texas, was elected chairman; B. B. Cloudt, of the Agricultural and Mechanical College of Texas, vice-chairman; and Garth Fuquay, of Texas Technological College, secretary. The first regular conference will be held in the spring of 1940 at the time and place of the spring meeting of the Texas Section. The officers will also constitute a committee to bring in a constitution and to act as a program committee for the conference.

The Texas Section at its business meeting that same day enthusiastically approved the student plan and announced the posting of generous prizes for the best student papers and the continuance of the plan for student breakfasts at Section meetings.

The interest of students in these activities is well illustrated by the distance traveled by the representatives from Texas Technological College, who drove the 650 miles to Corpus Christi—incidentally without a stop except for gasoline and food.

MARYLAND–DISTRICT OF COLUMBIA—MAY 4–5

A conference of the four Student Chapters in the Maryland-District of Columbia region was held at Catholic University, Washington, D.C., on Thursday and Friday, May 4–5. The Local Sections in the District of Columbia and Maryland gave active support to the conference. The Johns Hopkins Chapter sent 21 representatives; the University of Maryland, 19; George Washington University, 10; and Catholic University, 21.

After Dean Anthony J. Scullen had welcomed the conference to the campus, Field Secretary Jessup gave a report on the student conference at Chattanooga. This was followed by an address by Robert E. Dunning, a graduate of the University of Maryland, on "My Experiences at Job Finding." John G. Jory, a graduate of the Johns Hopkins University, spoke on "The Advantages of Employ by a Public Utility," while H. V. Darling discussed "The Advantages of Government Employ." Finally, Bernard Locraft gave advice on "The Young Engineer in Private Employ." Each address was followed by a lively and enthusiastic discussion.

On Thursday night 65 attended a banquet in Graduate Hall. The list of those present included Clifford A. Betts, secretary of the District of Columbia Section, and Deans J. R. Lapham, S. S. Steinberg, and Anthony J. Scullen. The feature of the occasion was an illuminating address on "The Civil Engineer's Part in the Government's Public Works Program," given by Senator James E. Murray of Montana.

On Saturday, R. Harvey Sargent, from a lifetime of experience with the U. S. Geological Survey, described the field and office methods used in making government topographical maps and showed samples of the work of the Survey in various stages. The exhibits included a lithographic stone with a map ready to go to press as well as recently developed substitutes of aluminum and copper for printing purposes.

Following luncheon and inspection of the campus and laboratories of the university, a field trip was taken to the Carderock Naval Testing Basin. There the government inspector, Herbert Dunber, described the problems encountered in the design and construction of the 1,100-ft building with its 100-ft arched roof, and their solution. The group then continued to the Gravelly Point Airport, where the hydraulic-fill project was visited.

Data for this report were furnished by Paul V. Douglass, secretary of the Chapter at Catholic University.

NORTHERN NEW YORK—MAY 6

The Chapters in northern New York held their fourth annual regional conference on May 6—this time as guests of the Student Chapter at Union College, Schenectady, N.Y. Representatives were present from the Chapters at Cornell University, Clarkson College of Technology, Rensselaer Polytechnic Institute, Syracuse University, and Union College.

The session opened Saturday morning with a business meeting, followed by a laboratory demonstration. The group sat down to luncheon at one o'clock, following which the representatives were welcomed by Dr. Dixon Ryan Fox, president of Union College, and Charles A. Harrell, vice-president of the Mohawk-Hudson Section. Then Edward W. Wendell, president of the Section, spoke on the problems that confront the young engineer.

During the afternoon, inspection trips were made to the new Schenectady incinerating plant and to a broadcasting studio of Station WGY. These trips were followed by a technical session and open forum with the presentation of prize-winning papers. Later the student representatives were guests of the Mohawk-Hudson Section for dinner and a regular Section meeting. The principal speaker was Emil H. Praeger, consulting engineer and recently appointed head of the department of civil engineering at Rensselaer Polytechnic Institute, who discussed "Parkway Engineering." The session concluded with the business meeting of the Section, which gave the students an opportunity to observe the handling of this aspect of Section affairs.

Kenneth B. Streeter was chairman of the Conference Committee. Data for this report were furnished by Charles S. Sterling, publicity director for the Mohawk-Hudson Section.

An Experiment in Student Guidance for Prospective Engineers

By Arthur G. Hayden, M. Am. Soc. C.E.

Chairman, New York Engineers' Committee for Student Guidance

The following account is taken from a report made recently by Mr. Hayden to the Board of Directors of the Metropolitan Section, in his capacity as chairman of that Section's Committee for Student Guidance. The work he describes is being carried on in the high schools of New York City, and is participated in jointly by committees representing all the principal branches of engineering, through the medium of the Engineers' Council for Professional Development.

Student guidance by engineers for seniors in New York City high schools has been in effect for two years. Students who expect to attend college after high school graduation and who have serious thought of following engineering as a career are given information, advice, and counsel by engineers in active practice so that they will be able to make a wise decision. This work is "engineered" by the New York Engineers' Committee for Student Guidance and its success has been largely due to the fact that all high schools in New York have able and interested student counselors—college advisers and vocational counselors—on their teaching staffs.

Student guidance along engineering lines is an activity of the Engineers' Council for Professional Development (E.C.P.D.) which is a conference of national engineering bodies, and the New York Engineers' Committee is under E.C.P.D.'s Committee for Student Selection and Guidance. The personnel of the New York Engineers' Committee is made up of the chairmen of the committees for student guidance of the local sections of the American Society of Civil Engineers, American Society of Mechanical Engineers, American Institute of Electrical Engineers, American Institute of Mining and Metallurgical Engineers, and American Institute of Chemical Engineers. The five committees average seven members each.

Activities for the year 1938–1939 (following committee meetings) began with a conference at Stevens Institute of Technology in Hoboken, N.J., on November 18, attended by eight representatives of the Engineers' Committee and twenty student counselors and representatives of the Division of Guidance and Placement in the city school system. Stevens Institute was host at the luncheon given for all those attending the conference, and after the luncheon the conference was addressed by the president of the Institute, Dr. Harvey N. Davis, who spoke in general about research in vocational aptitudes being conducted at the Institute and also the general problem of student selection from the point of view of the engineering colleges. Speakers for the Engineers' Committee explained their program, after which procedure for the year's work was discussed from the floor. The most valuable result of this conference was that members of the Engineers' Committee and of the Division of Guidance and Placement of the school system became acquainted with each other and that invitations to the Engineers' Committee from the high school principals, administrative assistants, or chairmen of student guidance committees followed.

How Conferences with Students Are Conducted

There are several phases of the contact work with the students. In a few instances the chairman and secretary of the Engineers' Committee are invited to attend a general assembly of students, sometimes numbering several thousand, in the school auditorium. Here the students are addressed by men and women prominently engaged in various industries, professions, and trades. Opportunities for employment are set forth and the special aptitudes necessary for success are outlined. Following such assembly, students gather in groups in separate rooms; those who are interested in engineering, for example, are given a room by themselves for a discussion of engineering as a career.

The time and space available for such conferences with students interested in engineering does not usually permit the more intimate contacts made when the Engineers' Committee visits a school alone. On such occasions there is no general assembly, but students interested in engineering meet with members of the committee in one or more small rooms. The school's student counselors cooperate with the committee in limiting these conferences to students who expect to attend college after high school graduation, who have a genuine interest in engineering as a career, and whose scholarship in mathematics, English, and the sciences (such as physics and chemistry) indicate that they would be successful in an engineering school. Such a selective process is necessary in schools having an enrollment of six or seven thousand students.

Those groups average about 70 students and are handled by an average of five members of the various societies' local section committees for student guidance, or sometimes by the committee chairmen themselves. Usually one member from each branch of engineering is in attendance. The entire group is first addressed and the nature of engineering in general is described and the mental and personal qualifications necessary for success in the engineering field are set forth. Emphasis is placed upon the fact that engineering students do not usually specialize in their courses until their senior year, and that it is not necessary for them to decide immediately whether they will be civil, mechanical, or electrical engineers, or otherwise specialized. After such a general address smaller groups are formed, but students can migrate from one group to another if they choose.

The engineers who preside over these smaller groups represent the chief branches of engineering—civil, mechanical, electrical, chemical, mining, and frequently aeronautical engineering in addition. In these smaller groups students can ask questions about any field of engineering, and in each the engineer tries to learn the proficiency of the students along lines of study that indicate aptitude for an engineering education, and to find out whether they possess the personal characteristics that a good engineer should have.

No attempt is ever made to induce students to take up engineering; on the contrary, it is pointed out that the engineering field is already overloaded with job-seekers having no higher ambition than to earn a livelihood, and the obstacles to be overcome before reaching full status as engineers are fully explained.

Contacts Arranged Between Individual Students and Engineers

The last phase of the work of the committee was entered upon with some hesitation but has so far proved successful, thanks to the intelligent cooperation of the splendid staff of student advisers in the schools themselves. Students in the groups are invited to request individual contacts with engineers actively engaged in the practice of their profession. Such requests must be made through the student counselors in the school, and reliance is placed by the committee upon the school counselor to observe a selective procedure. The counselors understand that the engineers, who stand ready to show students referred to them what the day's work of the engineer is, are busy men and that their time is limited. Hence requests for interviews are favorably considered only when students indicate by their scholarship that individual contacts will be of some value.

On recommendation from the counselor, the Engineers' Committee arranges an appointment for the student with some member of the Local Section committee or even with outside engineers. In these individual contacts the student is further informed what an engineer in practice does in his day's work, and is shown what is being done in offices and in the field. The Committee has received many expressions of gratitude from the high school counselors and from the students themselves endorsing this phase of the work. During the year from November 1938 to June 1939 about 75 students have been granted individual contacts out of about 1,970 who have been met in small group conferences.

No attempt has been made thus far to put into effect a formal analysis, by means of questionnaire or aptitude tests, of the qualifications of students for engineering education. Such procedure may be impractical at any time in a metropolitan district like New York; at any rate it would be obviously unwise to begin an activity like student guidance on too grandiose a scale. The activities of the past year, such as they are, have entailed a great deal of work on the part of a few men. As the work progresses it may be safely spread, and more details tried out. For the present it seems wise to attempt only to offer the opportunity to likely students to learn all they can about engineering as a career and to give them all the information possible so that they can make their own choice wisely.

Texas and Mid-South Sections Have Two-Day Meetings

A FINE PROGRAM of technical papers and social events marked the spring meeting of the Texas Section, held in Corpus Christi on April 28 and 29. The meeting was called to order on Friday morning by J. C. Bisset, chairman of the Arrangements Committee, who recalled the fact that the Texas Section was organized in Corpus Christi 26 years ago. Mayor A. C. McCaughan then welcomed the members to Corpus Christi, and L. R. Ferguson, president of the Section, responded in the name of the Section.

Colonel L. M. Adams, director of the Nueces Navigation District, initiated the technical program with a paper on "The Port Development at Corpus Christi." Others who addressed the morning session were Byrd Harris, traffic manager for the Nueces County Navigation District, who discussed problems of transportation; and W. Armstrong Price, consulting geologist of Corpus Christi, whose topic was "Recent Developments in Geo-Physical Surveying." All these papers were discussed.

At noon about 100 attended a luncheon in the Nueces Hotel. No formal program had been prepared, but President Ferguson introduced to the group Directors Bres and Leeds, Vice-President Noyes, and Allen P. Richmond, assistant to the Secretary. Colonel Bres spoke briefly.

The speakers at the afternoon session were S. M. Nixon, of the Southern Phillips Corporation, who discussed "The Relation of Engineering to Business"; and E. N. Noyes, Vice-President of the Society and consulting engineer of Dallas, whose topic was, "The Corpus Christi Sea Wall Project." The meeting adjourned early to enable those present to visit this project. In the evening there was an informal dinner dance at the Hotel Plaza.

Early Saturday morning there was a breakfast for Student Chapter members attending the meeting. President Ferguson presided at this function and spoke briefly on the desirability of organizing a Student Chapter Conference for Texas. Mr. Richmond also spoke on this subject, as did John A. Focht, J. T. L. McNew, and Vice-President Noyes. The members then adjourned for the last technical session, while Mr. Richmond remained with the students to help them organize a Student Chapter Conference.

The program at this session consisted of a talk by O. N. Stevens, vice-president and general manager of the Southern Alkali Corporation. Mr. Stevens' subject, "Alkali Comes to the Southwest," inspired a great deal of discussion. A business session, during which various committee reports were heard, concluded the meeting. Members then boarded a boat for a trip down the ship channel, luncheon being served on the boat. This trip was made possible through the courtesy of Frank T. Brady.

Approximately 200 were registered for the various events.

MID-SOUTH SECTION HAS ANNUAL MEETING

On May 5 and 6, about 165 members and guests of the Mid-South Section gathered in Memphis, Tenn., for the tenth annual meeting of the Section. Of special interest was the presence of a delegation of 15 Student Chapter members from the University of Mississippi and Mississippi State College.

The program, arranged for the interest of Mid-South members, included talks on the TVA power situation at Memphis by Maj. Thomas H. Allen, vice-president and chief engineer of the Memphis Light, Gas, and Water Division; "What's Wrong in Europe," by D. M. Amacker, professor of political science at Southwestern University; "Development of Malaria Control," by J. A. Le Prince, sanitary engineer director for the U. S. Public Health Service at Memphis; "Malaria Control in Memphis," by J. L. Robertson, sanitary engineer for the U. S. Public Health Service at Memphis; "Slum Clearance and Housing in Memphis," by Albert H. Fletcher, sanitary engineer for the City of Memphis; "Memphis Flood Control Project," by Maj. Daniel Noce, district engineer for the U. S. Engineer Office at Memphis; "Sardis Dam," by Lt. Col. R. G. Moses, district engineer for the U. S. Engineer Office at Vicksburg; and "Construction Features of Sardis Dam," by Capt. K. B. Schilling, project engineer on Sardis Dam. There were also informal talks by Robert B. Brooks, Director of the Society, and by James L. Ferebee, Vice-President of the Society.

On Friday the Section enjoyed a joint luncheon with the Memphis Engineers Club. The dinner that evening was attended by 190 members and guests. Following a talk by Tom Collins, assistant to the publisher of the *Kansas City Journal*, there was an entertaining floor show, after which the guests adjourned for dancing.

During the business session on Saturday morning the following officers were elected for the coming year: W. W. Zass, president; Nelson H. Rector, vice-president; and Forrest L. Dye, Jr., secretary-treasurer. At the conclusion of the business meeting the members went by automobile to Sardis, Miss., where an enjoyable buffet luncheon was served. At the dam site Captain Schilling provided guides to show the guests the various features of the project.

Bringing Professional Records Up to Date

ABOUT the first of May, several thousand circulars were sent out from Society Headquarters in an attempt to complete the file of professional records of members which has proved of much value in recent years. When a man makes application for membership in the Society, he is required to furnish a full account of his education and of his accomplishments up to that time. Most of the members, however, do their more important work after they have been elected to Society membership, and it is surprising to discover how modest they are when it comes to placing a permanent record of such achievements on file. The "Professional Record File" was established in 1921, to make available all recent information about members of the Society. Although blanks have been sent to all members three times since then, a recent check-up disclosed that perhaps 50 per cent of the present membership had never filled in this particular form and returned it to Headquarters.

The response to the most recent request has been encouraging. Up to the time of going to press, over 200 members have come through with a full record, and more records are being received in every mail. The information thus made available is of particular value in the publicity campaign now being carried on by the Local Sections. Section officers write in to Headquarters for the data, and it is a great satisfaction to be able to send them a copy of material that is correct and up to date. The file is also used (through a subject index) by the Engineering Societies Employment Service, when men are desired who have special qualifications for particular jobs. The editorial staff at Headquarters makes frequent use of the material, and questions are often answered from publishers of reference works on biography.

Forecast for June "Proceedings"

LARGE CORE DRILLS AID CONSTRUCTION AT CHICKAMAUGA DAM

By James S. Lewis, Jr., Assoc. M. Am. Soc. C.E.

A detailed description of construction procedure in drilling holes as large as 72 in. in diameter.

WIND BRACING IN STEEL BUILDINGS

SIXTH PROGRESS REPORT OF SUBCOMMITTEE 31, COMMITTEE ON STEEL, OF THE STRUCTURAL DIVISION

A discussion of approximate methods of determining column reactions from a consideration of stiffnesses only; effect of direct deformation in the columns on the stresses in a wind bent; torsional effects of wind on buildings; and magnitude of the assumed wind force on tall buildings.

American Engineering Council

The Washington Embassy for Engineers, the National Representative of a Large Number of National, State, and Local Engineering Societies in 40 States

Civil Service Seeks Advice from Profession

The President's Committee on Civil Service Improvement has authorized the appointment of a number of special advisory committees and Gano Dunn, a member of the President's committee, with the assistance of officers of the National Academy of Sciences, the National Research Council and others, the American Engineering Council, the American Society of Civil Engineers, and other leading engineering and technical societies, has appointed three such committees of five members each—one, covering the fields of mathematical, physical, and biological sciences, called for short, the Science Committee; a second, covering the fields of the general engineering societies consisting of the American Society of Civil Engineers, the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the Institute of Radio Engineers, which is known as the General Engineering Committee; and a third, covering the fields of the specialized engineering societies, consisting in part of the American Society of Heating and Ventilating Engineers, the Society of Automotive Engineers, the American Society of Agricultural Engineers, the Illuminating Engineering Society, the American Society of Refrigerating Engineers, and representatives of local and state engineering societies, to be known as the Specialized Engineering Committee. The members of these three committees are as follows:

Science Committee:

Dr. Ross G. Harrison, Chairman; National Research Council, care of Yale University, New Haven, Conn.

Dr. John A. Fleming, Director, Dept. Terrestrial Magnetism, Geophysical Laboratory, Carnegie Institution of Washington, Washington, D.C.

Dr. Lyman J. Briggs, Director, Bureau of Standards, Washington, D.C.

Dr. W. C. Mendenhall, Director, Geological Survey, Washington, D.C.

Dr. Roger Adams, Professor, Organic Chemistry, University of Illinois, Urbana, Ill.

General Engineering Committee:

Mr. E. P. Goodrich, Chairman; Consulting Engineer; Chairman, Committee on Salaries, Am. Soc. C.E., 175 Fifth Avenue, New York, N.Y.

Dean R. L. Sackett, Chairman, Committee on Merit System of American Engineering Council; Former Vice-President American Society of Mechanical Engineers, Hotel White, Lexington Ave. and 37th Street, New York, N.Y.

Mr. S. D. Kirkpatrick, Editor, *Chemical and Metallurgical Engineering*, 330 West 42nd Street, New York, N.Y.

Prof. W. B. Plank, Head of Department of Mining Engineering, Lafayette College, Easton, Pa.

Mr. Ovid W. Eshbach, Fellow, American Institute of Electrical Engineers; Personnel Relations Department, American Tel. and Tel. Company, 195 Boardway, New York, N.Y.

Specialized Engineering Committee:

Mr. J. S. Dodds, Chairman; Vice-President, American Engineering Council; Chairman, A.E.C. Committee on Economic Status of Engineers, Box 207, Ames, Iowa.

Mr. Samuel P. Lyle, President, American Society of Agricultural Engineers; Bureau of Agricultural Engineering, Department of Agriculture, Washington, D.C.

Mr. Thomas Urdahl, Consulting Engineer; Chairman, Admissions Committee of the American Society of Heating and Ventilating Engineers, 722 Jackson Place, N.W., Washington, D.C.

Capt. Harold D. King, Commissioner, Bureau of Lighthouses, Department of Commerce; Washington Society of Engineers, Washington, D.C.

Mr. Henry T. Woolson, Executive Engineer, The Chrysler Corporation; Past-President, Society of Automotive Engineers, Highland Park, Mich.

The memberships in these committees have been selected with reference to qualifications for formulating valuable opinion on civil service matters either through present or past employment in the government service, experience with merit systems in private industrial or educational fields, or demonstrated personal interest in and knowledge of the history and present problems of the Civil Service.

Federal Public Works Agencies Combined by Presidential Order

Exercising the authority granted him under the new reorganization act, President Roosevelt on April 25 submitted to Congress the first of three plans for regrouping the functions of various agencies of the federal government, to become effective in 60 days unless disapproved, as a whole, by a majority vote of both the Senate and the House of Representatives within that period, or unless Congress in the meantime adjourns. Since the House on May 3 voted down a resolution of disapproval, only an early adjournment could prevent its taking effect on June 24.

The plan brings to practical fruition the long campaign, actively promoted by American Engineering Council, for the establishment of a federal Department of Public Works. While the terms of the reorganization act prohibit the setting up of a new cabinet department, as originally projected by American Engineering Council, the Federal Works Agency proposed by the President will be its substantial equivalent. To it are transferred the functions and personnel of "those agencies of the federal government dealing with public works not incidental to the normal work of other departments, and which administer federal grants or loans to state and local governments, or other agencies, for the purpose of construction."

Transferred to the Federal Works Agency will be the Bureau of Public Roads, now in the Department of Agriculture; the Public Buildings Branch of the Procurement Division, Treasury Department (which designs and supervises construction of federal buildings in all parts of the country); the Branch of Building Management of the National Parks Service, Department of Interior (which selects sites for and determines the order of construction of public buildings in the District of Columbia); the U. S. Housing Authority, now in the Department of the Interior (slum-clearance); the Public Works Administration and the Works Progress Administration (both independent agencies set up on a temporary basis). Still unchanged is the present supervision of the Corps of Engineers over river and harbor improvements and flood control works, since this agency was specifically exempted by the reorganization act.

Heading the new agency will be a Federal Works Administrator to be appointed by the President with the advice and consent of the Senate, at a salary of $12,000 per year, and an Assistant Federal Works Administrator at $9,000. The present heads of the units transferred to the agency will, in general, be retained, and will report to the Administrator. Any personnel in excess of the needs of the new agency will be transferred to other government posts or given a preferred status on eligible lists for future employment.

The general plan for reorganization, as set forth in the President's message, envisions two additional new agencies to be known as the Federal Security Agency and the Federal Loan Agency. The present major independent agencies of the government (except those exempted by law) will be attached either to one of these three, to one of the ten existing executive departments, or, in a few instances, to the White House executive office.

Assigned to the new Federal Security Agency will be those existing bureaus and divisions of which the major purpose is to promote social and economic security, educational opportunity, and health, including the Social Security Board, now independent; the U. S. Employment Service from the Department of Labor; the Department of the Interior's Office of Education; the Public Health Service of the Treasury; the National Youth Administration, now part of WPA; and the Civilian Conservation Corps.

In the Federal Loan Agency will be concentrated several hitherto independent loan agencies set up to stimulate and stabilize financial, commercial, and industrial enterprises: Reconstruction Finance Corporation; Electric Home and Farm Authority; Federal Home Loan Bank Board; Federal Housing Administration; and Export-Import Bank.

Closer control by the chief executive of the three functions of management—budget, planning, and personnel—is provided for by the transfer to the executive office of the Bureau of the Budget, now in the Treasury Department; the National Resources Committee, now a temporary independent agency; and the Federal Employment Stabilization Board from the Department of Commerce. Because of an exemption in the reorganization act, a transfer to this office of the Civil Service Commission was impossible, but the President's message stated that one of his six new assistants will serve as a liaison man on personnel problems.

PATENT INQUIRY REQUESTS DATA FROM ENGINEERS

THE Patent Inquiry now being conducted by Council in collaboration with the National Association of Manufacturers and the National Industrial Conference Board is making steady progress, with a number of special studies now actively under way and others ready for assignment. A preliminary survey of the legal aspects of the patent system has brought to light specific questions which are now being organized into specific projects as collateral undertakings. Intensive study is being given the proposed single Court of Patent Appeals with the object of developing a statistical treatment of its merits and drawbacks. Specific studies relating to strandards for the patent specification, the function of the patent, Patent Office procedures, compulsory licensing, and foreign patent practice have reached the point where rough drafts of the manuscripts are being received for critical review. The initial section, dealing with the broad aspects of research and invention, has been outlined and now awaits specific assignment to specialist contributors.

In order to ascertain whether the engineer, as an inventor, has found that patents serve him usefully, a questionnaire has been prepared for distribution through all the leading engineering societies. [Information concerning this questionnaire appears in the Items of Interest section of this issue of CIVIL ENGINEERING.]

Washington, D.C.
May 5, 1939

"Hoover Dam" Adopted as Society Usage

BASING its action on the Cummings-Ickes correspondence in regard to "Boulder Dam," made public in March 1939, the Committee on Publications on April 16 adopted the name "Hoover Dam" for use in the Society's publications in reference to that structure. This was the name originally given to the dam, to memorialize Herbert Hoover, Hon. M. Am. Soc. C.E.

In the correspondence in question, dated early in 1935, Harold L. Ickes, Secretary of the Interior, criticized Homer Cummings, then Attorney General, for his reference to "Hoover (Boulder) Dam." Mr. Cummings, in reply, indicated that in his opinion the name had never been officially changed from "Hoover Dam." He called attention to the fact that this name was used by Congress in appropriating the money for its construction and was also used in contracts between the government and the Metropolitan Water District. The letters became public when Mr. Cummings, on leaving office, released some of his papers to a writer for publication in book form.

In adopting this usage, the Committee on Publications has recognized two considerations: (1) the validity of the name "Hoover" in this connection as recognized by high authority; and (2) the just acknowledgment to an eminent engineer and statesman for his share in a monumental project. Further, it is felt that engineers should be among the first to thus signalize in such an objective manner one of the foremost members of their own profession, and an Honorary Member of the Society.

Appointments of Society Representatives

A. J. HAMMOND, Past-President Am. Soc. C.E., represented the Society at the presentation ceremony of the Washington Award to DANIEL W. MEAD, Past-President and Hon. M. Am. Soc. C.E., in Chicago on February 20, 1939.

OTIS E. HOVEY, Hon. M. Am. Soc. C.E., and HARRY D. WINSOR, Assoc. M. Am. Soc. C.E., have been appointed a committee to prepare a memoir of ROBERT RIDGWAY, Past-President and Honorary Member Am. Soc. C.E.

R. C. MARSHALL, JR., M. Am. Soc. C.E., has been appointed the Society's representative on the Division of Engineering and Industrial Research of the National Research Council.

N. A. RICHARDS, M. Am. Soc. C.E., has been appointed to represent the Society on the Sectional Committee on Building Code Requirements for Reinforced Gypsum Concrete of the American Standards Association.

LOUIS YAGER, M. Am. Soc. C.E., has been appointed to prepare the memoir of WILLIAM L. DARLING, Hon. M. Am. Soc. C.E.

AN UNUSUALLY LARGE NUMBER OF WOMEN GUESTS ATTENDED THE SPRING MEETING AT CHATTANOOGA
The Group Shown Here Took Part in the Excursion to Fairyland Club

News of Local Sections

Scheduled Meetings

Alabama Section—Inspection trip at the Government Wharf, Mobile, Ala., on June 16, at 3:00 p.m.

Central Ohio Section—Luncheon meeting at the Chittenden Hotel in Columbus on June 15, at 12 m.

Indiana Section—Luncheon and inspection at the Indianapolis Water Company on June 16, at 2 p.m.

Los Angeles Section—Annual field day at Altadena Country Club on June 10, at 2:30 p.m.

Mid-Missouri Section—Outing and inspection trip at Bagnell Dam. Meet at Hahatonka Hotel on June 3, trip starting at 3:00 p.m.

Northwestern Section—Regular meeting on June 5.

Philadelphia Section—Outing, dinner, and annual meeting at the Sandy Run Country Club on June 15. Sports in the afternoon; dinner at 6 p. m.

Sacramento Section—Regular luncheon meetings at the Elks Club every Tuesday at 12:10 p.m.

Tennessee Valley Section—Dinner meeting of the Chattanooga Sub-Section at the Y.W.C.A. on June 19, at 6:30 p.m.

Tri-City Group—Dinner meeting at Harper House, Rock Island, Ill., on June 16, at 6:30 p.m.

Recent Activities

Buffalo Section—*March 14:* The feature of this luncheon meeting was a talk by Louis S. Bernstein, chief design engineer for the Buffalo-Niagara Electric Company. Mr. Bernstein described the construction of a submerged weir in the Niagara River just above the Horseshoe Falls, illustrating his remarks with lantern slides.

Central-Illinois Section—*Springfield, March 24:* Following dinner W. W. De Berard, Director of the Society and associate editor of *Engineering News-Record*, discussed recent Board activities. The technical program consisted of the presentation of sound motion pictures, illustrating the use of new types of construction equipment on industrial and engineering projects. These were shown by John Miner, research engineer for the Allis Chalmers Company.

Cincinnati Section—*April 12:* A joint meeting with the University of Cincinnati Student Chapter. During the evening it was announced that this year the Cincinnati Section's annual award of junior membership in the Society goes to Donald Frye, president of the University of Cincinnati Student Chapter. The main speaker of the evening was Dr. Otto C. Von Schlichten, of the geology department of the university, who gave an illustrated lecture on the subject, "Geologic History of Cincinnati and the Civil Engineer."

Cleveland Section—*April 4:* A talk on "The Rôle of Soil Mechanics in Foundation and Earthwork Construction" was enjoyed on this occasion, the speaker being George Paaswell. Mr. Paaswell is secretary-treasurer of Spencer and Ross, Inc., of Detroit, and an authority on foundations.

Colorado Section—*Junior Association, February 6, March 6 and 27:* On February 6 the Juniors heard Howard L. Wiley, chemical engineer and rubber technologist for the Gates Rubber Company, discuss the use of rubber in engineering. On March 6 a member of the staff of the General Land Office outlined the history and duties of that office. A discussion of the activities of the Society in their relation to the welfare of the profession initiated the meeting on the 27th. Later J. E. Warnock, hydraulic research engineer for the U. S. Bureau of Reclamation, presented four reels of motion pictures showing various hydraulic structures in operation.

Connecticut Section—*New Haven, April 26:* Annual dinner meeting with the Yale University Student Chapter. An innovation at this session was the presentation of the Section's first annual prize of Junior membership in the Society. This award went to W. E. Adams, a member of the Yale University Student Chapter. The annual election of officers resulted as follows: Warren J. Scott, president; W. A. D. Wurts, vice-president; and Joseph P. Wadhams, secretary-treasurer. The first speaker on the program was E. J. Beugler, secretary of the Board of Registration of Professional Engineers in Connecticut, who made an address of welcome to the students. He was followed by the guest speaker, William J. Cox, state highway commissioner. Mr. Cox discussed the various activities of the highway department, stressing particularly recent plans for opening additional sections of the Merritt Parkway.

Dayton Section—*April 24:* Following a luncheon, B. S. Kelsey, of the U. S. Army Air Corps, gave a talk on the "Modern Military Airplane." In his talk Lieutenant Kelsey covered the engineering and scientific considerations, which make possible the success of the modern plane.

Duluth Section—*March 20:* Local problems of street car and bus operation were discussed at this luncheon meeting. The main speaker was R. B. Thompson, manager of the Duluth Superior Transit Company, who outlined the factors that make the maintenance of street car service uncertain.

Florida Section—*Tallahassee* and *Jacksonville, April 24* and *25:* Joint sessions with the Engineers and Architects Club of Tallahassee and the Engineering Professions Club of Jacksonville, respectively. Field Secretary Jessup was the principal speaker at both meetings, discussing the aims and activities of the Society and the relationship of the Society to other professional groups.

Georgia Section—*Atlanta, April 10:* The principal address was given by F. H. Frankland, chief engineer of the American Institute of Steel Construction, who made a special trip from New York for the occasion. Dr. Frankland's topic was "Corrosion of Structural Steel and Its Prevention."

Illinois Section—*Evanston, Ill., April 26:* Joint meeting with the Northwestern University Student Chapter. After David Emerson, president of the Chapter, had welcomed the visitors, a member of the faculty discussed the rôle of the United States in the European situation. Then L. D. Gayton, city engineer of Chicago, showed pictures of Chicago bridges, both old and modern, and the meeting concluded with a talk on the new technological school. This was given by George A. Maney, professor of structural engineering at the university.

Kansas City Section—*April 13:* A talk on the Kansas City Municipal Airport initiated the program on this occasion, the speaker being C. D. Dailey, manager of the airport. Lieutenant Dailey described the development of local airport facilities since 1926. He was followed by Howard K. Morgan, superintendent of communications for Transcontinental and Western Air Lines in Kansas City, whose subject was "New Developments in Aircraft Communication." These two speeches inspired an interesting general discussion of flying in its relation to the defense program of the country.

Kansas State Section—*Manhattan, Kans., April 13:* Joint session with the Student Chapters at Kansas State College and the University of Kansas. Richard Lindgren, acting as toastmaster, introduced Harold E. Brown and J. R. Shipley, who spoke for their respective Student Chapters. Then W. E. Baldry, former president of the Section, addressed the students briefly, and G. W. Bradshaw gave a report on Student Chapters. The main speaker was L. E. Conrad, professor of civil engineering at Kansas State College, who gave an illustrated lecture on the Seminoe Dam in Idaho. Musical entertainment consisting of a trumpet solo and singing was also enjoyed.

Kentucky Section—*Frankfort, March 24:* The speakers at this dinner meeting were T. H. Cutler, state highway engineer of Kentucky, and M. R. Keefe, state highway engineer of Indiana. Mr. Cutler gave an illustrated talk on "Impressions of Modern Dutch and German Roads," while the latter discussed road construction in Persia.

Lehigh Valley Section—*Bethlehem, Pa., March 15:* A joint meeting with the Engineers Club of the Lehigh Valley. The sub-

ject of discussion, "Developments in Attractive Moderate Cost Homes," aroused considerable enthusiasm, and many questions were asked at the conclusion of the lecture. The speaker was John Ely Burchard, director of the Albert Farwell Bemis Foundation at Massachusetts Institute of Technology.

LOS ANGELES SECTION—*April 12:* A symposium on the new Union Passenger Terminal in Los Angeles, which was placed in operation on May 3, proved of great interest on this occasion. The completion of this station climaxes a twenty-year effort on the part of the city to obtain a union terminal for its three transcontinental railroads. Those taking part in the symposium were Archer F. Barnard, consulting engineer of Los Angeles; M. C. Blanchard, chief engineer of the Santa Fe Lines west of Albuquerque; Paul Lebenbaum, of the Southern Pacific Railroad Company; and A. J. Barclay and C. L. A. Bockemohl, respectively construction engineer and structural engineer for the terminal. A tour of the terminal preceded the meeting.

MARYLAND SECTION—*April 15* and *27:* An unusually large number of members went to Gibson Island on the 15th to enjoy the Section's annual "oyster roast." At the regular meeting in Baltimore—on the 27th—F. A. Allner spoke on the subject, "Recent Federal Power Developments in the West and the Economics of Multiple Purpose Projects." Mr. Allner illustrated his talk with slides taken during a recent extensive tour of the West.

METROPOLITAN SECTION—*New York City, April 19:* This session was devoted to a symposium on "The Housing Program in Greater New York." The illustrated talk by Alfred Rheinstein, chairman of the New York City Housing Authority and New York City Commissioner of Housing and Buildings, aroused an unusual amount of discussion from the floor. As a result the meeting was pronounced one of the most successful of the current season.

MID-MISSOURI SECTION—*Jefferson City, March 31:* Following dinner, Jack Terrill gave a review of four articles appearing in recent issues of CIVIL ENGINEERING. The address of the evening was delivered by Dr. H. A. Buehler, state geologist, who discussed the mineral resources of Missouri and the use that engineers are making of them. Many questions were asked at the conclusion of Dr. Buehler's talk. The list of guests included Luis Cuevas, engineer of the Republic of Mexico.

MOHAWK-HUDSON SECTION—*Schenectady, N.Y., May 6:* Representatives attending the Third Annual Northeastern Regional Student Conference (held at Union College during the day) were guests of the Section at a dinner and the meeting following it. The speaker of the evening was Emil H. Praeger, consulting engineer and newly appointed head of the department of civil engineering at Rensselaer Polytechnic Institute. Mr. Praeger's subject was "Parkway Engineering." During the business session it was announced that John A. Wallace has been appointed secretary of the Section to fill the vacancy caused by the resignation of Paul R. Spear, who is moving to another city. It was also announced that, although the Section is officially less than a year old, it has to date enrolled approximately 38 per cent of the Society membership in its territory.

NEW MEXICO SECTION—*Albuquerque, March 30:* Many members of the University of New Mexico Student Chapter attended this session, which was held on the campus of the university. The technical program consisted of a talk by H. C. Neuffer on the Grand River Project and hydraulic development in Oklahoma. Mr. Neuffer is consulting engineer on this project.

NORTH CAROLINA SECTION—*Pinehurst, April 29:* This annual meeting, consisting of a morning and an afternoon session, was devoted to business. Various committee reports were read, and Field Secretary Jessup was present to discuss Society actions of interest to the Section. The annual election of officers held at this time resulted as follows: Frank T. Miller, president; W. G. Geile, junior vice-president; and Harold C. Bird, secretary-treasurer. A. C. Lee was automatically advanced from the position of junior vice-president to that of senior vice-president. In a brief talk Mr. Miller asked for the cooperation of the Section during the coming year.

NORTHEASTERN SECTION—*Boston, March 29:* On this occasion the members enjoyed an illustrated historical lecture on the subject, "Freres Du Pont, Religious Order of Bridge Constructors of the Middle Ages." At the close of the lecture there was interesting discussion by Prof. Charles M. Spofford and others. The subject of the formation of an association of the Juniors of the Section was then discussed at some length. *Cambridge, April 21:* Joint session with the Boston Society of Civil Engineers. There was much interest in the technical program, which consisted of a lecture on the New York World's Fair. This was given by Col. John P. Hogan, chief engineer and director of construction of the fair. A dinner at the Harvard Faculty Club preceded the meeting.

OKLAHOMA SECTION—*Oklahoma City, March 31:* The technical program consisted of talks by C. A. Bullen, superintendent for the W. S. Bellows Construction Company, of Houston, Tex., and H. M. House, engineer for the Oklahoma WPA. Mr. Bullen gave an illustrated lecture on the construction of the San Jacinto monument, on which his firm was contractor, while Mr. House showed and explained several reels of pictures of WPA projects in the state.

OREGON SECTION—*Portland, April 26:* A combination dinner meeting and inspection trip was enjoyed on this occasion. First, George W. Buck, engineer for Multnomah County (Oregon), described the construction of the Rocky Butte and Barnes Road tunnels. The members then visited these two projects under the guidance of Mr. Buck, who explained the excavation and lining processes.

PHILADELPHIA SECTION—*March 15* and *April 19:* The first speaker at the March meeting was Howard T. Critchlow, chief engineer of the New Jersey State Water Policy Commission, who outlined briefly "Governor Moore's Plan" for diverting water from the Delaware River and making it available to the cities of northern New Jersey. Solomon M. Swaab, consulting engineer, then reviewed the Delaware River Diversion Case between New York and New Jersey, while W. D. Mason discussed salinity conditions in the Delaware. A lively discussion followed the presentation of these papers. The April meeting was devoted to the subject, "Construction and Operation of Streamline Trains," the speaker being J. W. Patton. Mr. Patton, who is an architect for the Edward G. Budd Manufacturing Company, discussed the design of these trains as well as their possibilities for the future. He then showed colored slides of some of the trains his company is building. A general discussion concluded the meeting.

PITTSBURGH SECTION—*March 16:* Joint session with the civil engineering section of the Engineers Society of Western Pennsylvania. An illustrated talk on "Water Supply and Disposal in Connection with Air Conditioning" was the feature of this occasion. The main speaker was George O. Weddell, of the York Ice Machinery Company. *Junior Division, March 2* and *April 27:* Both of these gatherings were dinner meetings. At the March meeting motion pictures covering hydraulics and other subjects were shown, with comments by J. W. Dougherty and W. S. Hamilton. The program on April 27 consisted of a symposium of ten-minute talks on the subject, "Our Jobs," followed by a question-and-answer period. Those contributing talks were A. P. Deemer, Jr., S. A. Cannistra, W. T. McKeon, W. S. Hamilton, and W. Bauknight.

SACRAMENTO SECTION—*April 4, 11, 18,* and *25:* At the first of these luncheons Haller Belt, Pacific Coast manager of the Bausch and Lomb Company, spoke on the topic, "The Eyes of Science." The meeting on the 11th was arranged and conducted by the Juniors, four of whom gave short talks on the traffic problem. These were C. R. Gallagher, Edwin Epstein, Alfred Brosio, and Francis Murphy. "Metering as a Basis of Water Control" was the subject of a talk given by S. R. Dows, of the Builders Iron Foundry, on April 18. The speaker on the 25th was Earl C. Thomas, professor of civil engineering at Stanford University, who discussed "Engineering Education in Our Schools and Colleges." The Section has sponsored the formation of a Junior Forum.

ST. LOUIS SECTION—*April 24:* As a departure from the usual serious program, those present heard Daniel Bartlett, St. Louis attorney, indulge in his avocation of humorist and raconteur. L. A. Pettus reported on the engineers' license bill, and R. B. Brooks, Sr., commented briefly on the Chattanooga Meeting.

SAN FRANCISCO SECTION—*April 18:* The feature of this occasion was the award of prizes of Junior membership in the Society to outstanding students. These awards went to R. A. Ray, of the University of California, and R. Matheu, of Stanford University.

An illustrated talk on "Engineering Features in the Construction of a Modern Seacoast Battery" was then given by F. B. Butler, captain, Corps of Engineers, U. S. Army. During the evening the membership committee reported a net gain of 29 members.

Spokane Section—*Pullman, Wash., March 22:* Joint meeting with the Student Chapters at the University of Idaho and Washington State College, the latter Chapter acting as host. The principal speaker was Timothy McCarthy, of Wallace Aerial Surveys, Inc., who discussed the equipment used in such surveys, the methods of surveying and the results. Prof. Howard E. Phelps spoke briefly in behalf of the Section.

Syracuse Section—*April 10:* At this session it was announced that the Committee on Fees and Salaries had arrived at a schedule satisfactory to the other engineering societies in the city, and it was decided to send copies of the schedule to each licensed engineer and land surveyor in the area with the request that he abide by it. The members then heard an interesting talk on present conditions in Europe, by Prof. C. Grove Haines, of the history department at Syracuse University.

Tacoma Section—*April 11:* At this session C. B. McCullough gave an illustrated lecture on his experiences in bridge building in Central America, with interesting sidelights on the history of the various countries and their people. Mr. McCullough is now assistant state highway engineer for the Oregon State Highway Commission.

Tennessee Valley Section—*Knoxville Sub-Section, April 11:* A large number turned out for the annual "Family Night." The program for the occasion consisted of talks by Dana M. Wood and A. L. Brown. Mr. Wood's subject was "Epitaphs," while Mr. Brown discussed his experiences in observing bird life and showed his colored motion pictures of scenery in Tennessee and South Carolina.

Toledo Section—*April 26:* This meeting took the form of an inspection trip through the plant of the Libbey Glass Company at Toledo. James Kievit, who is connected with the company, conducted the tour and explained the functioning of each department.

Tri-City Group (Davenport, Iowa, and Moline and Rock Island, Ill.)—*Davenport, May 13:* During the afternoon inspection trips were made to large construction projects in the Tri-City area, including Lock and Dam No. 15, one of a series of 26 navigation dams in the Upper Mississippi River Canalization Project. Out-of-town guests attending the meeting included Field Secretary Jessup and Directors Needles and De Berard. The principal speaker at the meeting was E. E. Gesler, district engineer of the Rock Island office of the U. S. Engineer Office. Colonel Gesler traced briefly the history of the improvement of the inland waterway, from its beginning to the time of the authorization of the Upper Mississippi River Canalization Project. Motion pictures showing the construction of Lock and Dam No. 13 at Clinton, Iowa, one of the dams in this project, were then presented, with explanatory remarks by Frank M. Thul, who was resident engineer on the construction of this $7,000,000 dam project. J. E. Jewett, temporary chairman of the local group, presided at the meeting, and H. P. Warren, chairman of the program committee, introduced the speakers.

Virginia Section—*March 23:* This was a luncheon meeting in honor of Field Secretary Jessup, who discussed with members the work of the Society and its relationship to the Section.

West Virginia Section—*Morgantown, April 12:* Practically every part of the state was represented at this spring meeting, which was pronounced the Section's most successful effort to date. The morning session was devoted to business, and the afternoon to the presentation of a technical program. Those who spoke were H. E. Rist, of the West Virginia University Student Chapter, who gave his reasons for choosing the profession of civil engineering; G. P. Boomsliter, professor of mechanics at the university, who presented a paper on the development of testing machines; and Prof. W. S. Downs, who discussed the Society's proposed salary scale. In the evening members of the West Virginia University Student Chapter were guests of the Section at a dinner. President Boltz acted as toastmaster, and Charles E. Lawall, president of the university, gave the official address of welcome. R. P. Davis, Director of the Society, spoke, as did Prof. A. E. McCaskey, Jr. The group then adjourned for a session with the Society of Professional Engineers, at which Maj. Roy D. Burdick discussed flood control on the Mississippi. Major Burdick also presented several reels of motion pictures showing flood control work in the Mississippi Valley.

Wisconsin Section: Several members of the Wisconsin Section took part in the 1939 Engineering Conference, sponsored by the Engineering Society of Wisconsin in Milwaukee, March 15 to 17. James L. Ferebee, chief engineer of the Sewerage Commission of Milwaukee, presided at the opening session, and Jerome P. Gebhard, president of Gebhard-Berghammer, Inc., was chairman of the structural engineering session. On the list of members presenting papers were M. W. Torkelson, director of regional planning for the state; Thomas M. Reynolds, division engineer for the Wisconsin State Highway Commission; and Berry E. Brevik, structural engineer for the Portland Cement Association. The Wisconsin Section sponsored the luncheon held on the opening day as well as the structural engineering session.

Student Chapter Notes

Ohio State University—*Columbus, April 3:* This meeting was pronounced one of the most successful in the history of the Chapter. Over 150 engineers and their engineer guests turned out on this occasion to hear Arthur E. Morgan, former chairman of the Board of Directors of the Tennessee Valley Authority. Dr. Morgan discussed the organization, operation, and benefits of the TVA program. A dinner for him preceded the meeting.

Members of the Rice Institute Student Chapter Visit Marshall Ford Dam

Rice Institute: In January members of the Rice Institute Student Chapter went to Austin, where they visited a meeting of the University of Texas Student Chapter. More recently they enjoyed an inspection trip to Marshall Ford Dam, on the Colorado River, near Austin. On this occasion members of the Chapter were guests of S. W. Oberg, chief civil engineer for the Humble Oil and Refining Company; J. H. Bringhurst, Contact Member for the Chapter; and two construction companies—Brown and Root and the McKenzie Construction Company. With time out for a delicious lunch, the members spent the day examining the project which was explained by the superintendent of construction. The students state that this year the engineers and business men of Houston have shown a great deal of interest in the student Chapter and that Mr. Bringhurst has spoken at two of their meetings.

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for July

An article on construction plant for buildings, scheduled for the July issue, carries the series on modern construction tools and practice into its fifth month. Incidentally, it introduces as of primary importance a factor to which relatively little attention has had to be given in the earlier papers. That factor is the restrictions imposed by certain trade unions on the use of mechanical labor-saving devices—restrictions which "to a large extent regulate the development and application of equipment to the field work involved in the construction of buildings." R. L. Bertin is the author, and the paper was given before the Construction Division at the 1939 Spring Meeting.

The Spring Meeting also provided a group of five interesting papers in the field of hydraulics, all of which will appear in forthcoming issues of Civil Engineering. It is probable that of these, the ones by Gerard H. Matthes and Fred C. Scobey will be published in July. Mr. Matthes, writing on "Observational versus Experimental Hydraulics," makes an urgent plea to hydraulic engineers to revive interest in "field study of hydraulic phenomena"—the form of research "which draws its conclusions from observations made in nature" rather than from observations made on laboratory models. Mr. Scobey, in his "Notes on the Hydraulic Jump," lists seven practical uses of the jump and then takes up in order the topics of (1) when the jump can be expected, (2) when it may occur though not expected, and (3) when it may not occur, though expected.

Other papers on the July schedule treat of hydroelectric development, research in welded shear reinforcing in concrete beams, and highway problems.

A Significant Court Decision

By D. B. Steinman, M. Am. Soc. C.E.

A decision of significance to the professions has just been handed down in the New York Supreme Court—Special Term, Part V, by Mr. Justice Rosenman in the case of the American Store Equipment and Construction Corporation vs. Jack Dempsey's Punch Bowl, Inc., et al. This was an action to recover compensation for services rendered, including designing, arranging, and decorating, in addition to the architectural services of preparing plans and supervising construction. Since the plaintiff is not licensed as an architect and, being a corporation, could not in fact be licensed, judgment was rendered for the defendants. (The decision in full is recorded in the *New York Law Journal* May 4, 1939, page 2055.)

The following are especially significant items of the court's ruling:

1. An agreement by one who is not licensed to perform services requiring a license according to statute "is of such illegality that public policy will actually ban any recovery thereon even though the unlicensed party has performed the services undertaken."

2 The provisions of the licensing law were promulgated "to safeguard life, health and property."

3. The pertinent provisions in the architects' and engineers' licensing laws are almost identical.

4. A similar prior decision under the engineers' law in New York State is cited as a precedent. (Dinan Co., vs. Slater; 132, Mis., 454, affirmed 225 Appellate Division, 750.) "The same principles are applicable to architectural services; for both professions involve the safety and lives of the general public who use their structures."

5. The claim that only 5 or 10 per cent of the services undertaken to be rendered were illegal does not permit recovery for all those portions of the contract not involving professional services. The established rule is that "if any part of the consideration for his contract was contrary to public policy, the whole promise fails." Where part of an integral contract is illegal, "there can be no separation of acts to support proportional recovery."

6. "To sustain the legality of the balance of the agreements would lead to widespread disregard to the licensing statutes. It would be easy for any construction contractor to thwart the purposes for which the licensing of architects was enacted by merely providing in his contract that architectural services would be given gratis, so long as the contractor were awarded the contract itself."

7. "One instance of rendering such services is sufficient to bring a person within the category of practicing architecture. It is not necessary, under this provision, that a person make a regular business of performing similar services before he is obligated to comply with the licensing sections."

Data on Inventors' Experiences with Patents Sought by A. E. C.

Inventor members of the Society are invited, in their own interest, to contribute data on their personal experiences with patents to the Joint Patent Inquiry in which American Engineering Council is participating. A special questionnaire for recording these data will be supplied by Council on request. The following statement by Fairfield E. Raymond, Director, Joint Patent Inquiry, outlines the objectives of the project.

Engineers have a vital professional interest in the operation of our traditionally American patent system. It is through the privileges created by the constitutional provision permitting patent grants that technological development, through which many engineers derive their principal basis of livelihood, has been fostered. Thus it is that the American Engineering Council, as the representative of the engineering profession at large, has been looked to as an impartial agency to carry forward a joint inquiry into the whole patent situation, in conjunction with the National Association of Manufacturers and the National Industrial Conference Board.

The patent and the system through which it is created has been primarily regarded as an essential medium to facilitate the translation of invention into products or services. Though there is less cause to question the basis upon which the patent itself is founded, a realignment of factors caused by the increasing complexity of business and the severity of competition has given cause to question many of the ways in which the patent privilege has been put to use.

It is of primary importance, accordingly, to ascertain whether patents have had their intended usefulness to the engineer as an inventor. Has he been able to successfully put to use his inventions and derive a satisfactory benefit from them? Does the patent provide him with a positive and effective means to assert his claims against others who have devised similar technical improvements? What channels have been made available to him through the patent to convey title to his invention to those who can make best use of it, and what obstacles has he met with?

To obtain a broad and representative cross-section of the experience of engineers at large with the patent system and the use of their patents, the questionnaire that has been prepared for this inquiry is being brought to their attention through the cooperation of their professional societies. A true picture of the engineer's relation to our patent system can only be set forth through the wholehearted response to this questionnaire by those who still have an interest in unexpired patents, or even those who have in the last 17 to 20 years made application for a patent, regardless of the fact that they may consider their own experience as nothing unusual or unique.

The questionnaire has been designed for convenience in making reply, and readers are urged to secure copies promptly from the American Engineering Council, 744 Jackson Place, Washington, D.C.

New Medal of Geophysical Union Honors William Bowie

FIRST AWARD of the Bowie Medal, recently established by the American Geophysical Union, was made to William Bowie, M. Am. Soc. C.E.—the man for whom it was named—at the general assembly of that organization in Washington, D.C., on April 28, 1939.

The medal was endowed by friends and co-workers of Dr. Bowie, to be awarded annually by the Union "for distinguished attainment and outstanding contribution to the advancement of cooperative research in fundamental geophysics." Plans for its establishment and for the initial presentation were so closely guarded that Dr. Bowie's first knowledge of it came when he was called to the platform to receive it. In fact, plans almost went awry when, just as the ceremonies began, he strolled out of the room, unnoticed, to quiet some noise in the hall. When his absence was discovered an informal steering committee got him back to his seat, and the announcement and presentation speech were repeated.

WILLIAM BOWIE

In his citation the president of the Union, Prof. R. M. Field, referred to the medal as "a talisman of those human forces—affection, esteem, and tradition—so fundamental to the spirit of progress." "It is hoped," he said, "that future awards of this medal will continue to promote and to recognize that spirit of helpfulness and friendliness in unselfish cooperative research which you have so bountifully displayed."

"Transporting the A.E.F." Available at Cost of Binding

THROUGH the courtesy of the Columbia University Press, a number of copies of *Transporting the A.E.F. in Western Europe*, by William J. Wilgus, Hon. M. Am. Soc. C.E., are being made available to Society members at \$3.00 each—the cost of binding and mailing.

This 612-page volume, published in 1931, is a comprehensive treatise on the subject, and should be of special value and interest to Army officers, both regular and reserve. Its author served during the War as Director of Military Railways, A.E.F., and Deputy Director General of Transportation, A.E.F.

In his introduction, Colonel Wilgus describes the transportation of the A.E.F. as "a transportation problem such as the world has never seen." Forces of unprecedented size "were to be disembarked with their supplies at a multitude of antiquated, shallow ports calling for drastic improvement and expansion, and thence moved inland up hill and down dale over a 6,000-mile network of rail and water lines of communication demanding improvement, manning, and equipment on a vast scale, to a battle front many hundred miles from the western and southern coasts of France."

"Realizing," he continues, "that without a full knowledge of the experiences through which the Transportation Service of the American Army passed in Western Europe, mistakes there made are sure to be repeated in some future emergency with peril to our country while they undergo slow correction, I have felt called upon to set forth the facts as I know them, based, not only on official documents, but also on my intimate association with the Service from its beginning until after the Armistice was signed."

Orders for the book must be placed with the Society, at 33 West 39th Street, New York, N.Y., before August 1, 1939, and must be accompanied by the full purchase price (\$3.00 per copy). Delivery of books will be made on or before October 1.

Intensified Mapping Favored in Joint Report of Secretaries of War, Commerce, and Interior

"The best statement of the mapping needs of the country I have ever seen," writes William Bowie, chairman of the Society's Surveying and Mapping Division, of the joint report recently submitted to the Senate by the Secretaries of War, Commerce, and Interior. This report, printed as S.D. 54, 76th Congress, 1st Session, is abstracted here.

"WE PROPOSE that the mapping of the United States, which now lags so far behind that of other leading nations, be immediately accelerated; that the program of acceleration begin with a 3-year period of expansion in the mapping activities of the federal agencies concerned; and that thereafter it go forward at a sustained but moderate level. . . .

"Basic three-dimensional contour maps, made by modern methods in accordance with accurate engineering standards, are recognized by the leading nations of the world as fundamental both to national defense and to the planning of internal improvements. . . .

"Less than 25 per cent of the United States is now covered by accurate topographic maps. In view of the fact that it has required more than 40 years to accomplish this much, and that at the present rate of progress more than a century will elapse before the entire country is mapped, the necessity for accelerating progress should be obvious. . . .

"The handicap under which the United States labors, by reason of the lack of accurate maps over so much of its area, is coming to be more and more acutely recognized by all units of government. . . . To satisfy only the more urgent of these would require the early coverage of more than one-half of the total area of the United States and substantial areas in the Territory of Alaska; far more than can be accomplished quickly under any reasonable program. . . .

"It is our conviction that... past neglect should be remedied by prompt action that will assure an efficient and continuous program of mapping in the future.

"Such a program should be designed to insure substantial progress in mapping in general, with proper priorities for those areas in which the needs are most urgent, particularly those areas of most importance from the point of view of national defense. To that end we recommend a program involving expenditures of \$5,000,000 for the first year, \$6,000,000 for the second year, and thereafter at a sustained level of not less than \$7,000,000 a year. It should be emphasized, moreover, that any technical program whose effective execution depends upon the development of a corps of especially trained engineers and the acquisition of special equipment, cannot be efficiently administered under a series of fluctuating annual grants. To be most effective and economical, it should be sustained at an approximately uniform level over a period of years.

"Attention is invited to the fact that the plan herein proposed is essentially like that contemplated in Senate Document 14, Seventy-fifth Congress. We believe that the general principles and the procedure advocated in that document are sound, but that present conditions justify some increase in the acceleration therein proposed.

"As in that document, it is recommended that the first and second order control surveys that precede mapping be executed by the Coast and Geodetic Survey of the Department of Commerce, and the supplemental control and the topographic mapping itself, by the Geological Survey of the Department of the Interior. Nuclei of the necessary staffs exist in these bureaus, . . . [and] can readily be expanded to the dimensions required by the program herein advocated, without waste, and without lowering the standards of accuracy that are required in modern topographic mapping. . . .

"The maps to be produced under this plan are general-purpose maps of standard scales. The preparation of expensive large-scale special-purpose maps is not contemplated; although, because the preliminary sheets are as a matter of efficient procedure prepared on larger scales than the final maps, many of the special needs of particular government agencies can be met by supplying them with copies or enlargements of these sheets.

"In view of the present disturbed state of world affairs, at least half of the program herein proposed should be devoted to mapping in strategic areas, . . . until the mapping of such areas shall be completed. This mapping, of course, will serve other purposes as well as those of defense. The remaining half of the program should be distributed over the United States and its Territories and possessions in accordance with priorities determined by the economic and developmental requirements of the country."

NEWS OF ENGINEERS

Personal Items About Society Members

KARL R. KENNISON, assistant chief engineer of the Metropolitan District Water Supply Commission, Commonwealth of Massachusetts, has been promoted to the position of chief engineer of the Commission, succeeding the late FRANK E. WINSOR.

STANLEY M. DORE succeeds KARL R. KENNISON as assistant chief engineer of the Metropolitan District Water Supply Commission. Mr. Dore was formerly associate civil engineer of the Commission.

JOHN C. RIEDEL, recently appointed chief engineer of the New York City Board of Estimate and Apportionment, was honored by over 600 engineers and city officials at a dinner held at the Hotel Commodore in New York on May 8. Mr. Riedel's service with the city began in 1901. He was appointed to his present position in March.

FRANK A. BANKS, construction engineer for the U. S. Bureau of Reclamation on the Grand Coulee Dam project, has been appointed to the position of acting administrator of the Bonneville Project to succeed the late J. D. Ross. Mr. Banks, who has been in the continuous employ of the Bureau of Reclamation since 1906, will continue his duties at Grand Coulee Dam while acting as administrator at Bonneville.

WILLIAM G. WOOLFOLK has been elected president of the United Light and Traction Company. He has also been made president of a number of affiliated utility companies, and he will continue to serve as president of the Michigan Consolidated Gas Company. His headquarters are in Detroit.

MURRAY J. BACKUS was recently appointed territorial representative of the Wage and Hour Division of the U. S. Department of Labor in San Juan, Puerto Rico. He was formerly an engineer in the New York City office of the PWA.

E. A. MCNATT is now associate highway engineer for the U. S. Bureau of Public Roads, with headquarters at Springfield, Ill.

JAMES B. HAYS has been transferred by the Tennessee Valley Authority from Chickamauga Dam, where he has been construction engineer for the past three years, to the same position at Gilbertsville Dam (Gilbertsville, Ky.), on which construction will soon be started.

JOHAN A. AALTO, formerly topographic draftsman in the Department of Engineering–Highways of the Borough of Queens, has been appointed assistant engineer in the Office of the Comptroller of the City of New York.

JAMES T. HALLETT has resigned as traffic engineer for the State Highway Commission of Indiana to accept a position with the Portland Cement Association, for which he is to engage in special research work in New York State.

K. B. WOLFSKILL, until recently with the bridge department of the State Highway Commission of Indiana, is now resident engineer-inspector for the PWA in Indiana.

PAUL A. BARATTINI, previously senior draftsman for the Borough President of Queens, has become a junior engineer for the North Beach Airport Planning Section with headquarters at Jackson Heights, N.Y.

BERNARD C. MOORE is at present employed as a junior engineer by the International Boundary Commission, with headquarters at El Paso, Tex. He was formerly assistant civil engineering aid in the U. S. Engineer Department at Galveston.

PHILIP G. HOLGREN, until recently with the Water Department of the City of Spokane (Wash.), has accepted a position in the Division Engineer's Office of the Chicago, Milwaukee, St. Paul and Pacific Railroad. He is now located in Seattle.

VICTOR L. STREETER has resigned as associate engineer for the U. S. Bureau of Reclamation to accept a position in a similar capacity with the International Boundary Commission. His headquarters are at El Paso, Tex.

FRED E. SWINEFORD, who has been in the State Highway Testing Laboratory at Ohio State University, is now assistant engineer in the Bureau of Location and Right of Way of the Ohio State Department of Highways, with headquarters at Columbus.

JOHN STEARNS, formerly division engineer of the Metropolitan Water District of Southern California, is now with the Federal Power Commission in Washington, D.C. Recently he was promoted from the position of senior engineer to that of principal engineer in the division of Power-Flood Control Studies.

CALEB MILLS SAVILLE has been awarded the "President's Premium" by the Council of The Institution of Water Engineers (England) for his paper, "Vagaries in Runoff from Catchment Areas in Southern New England," presented on May 25, 1938, at a meeting of that society. Mr. Saville is manager and chief engineer of the Water Bureau of the Metropolitan District, Hartford, Conn.

D. A. BUZZELL has resigned as chief hydraulic engineer of the Central Nebraska Public Power and Irrigation District to accept a position in the flood study department of the Federal Power Commission. He is stationed in Washington, D.C.

EDMUND L. DALEY, brigadier-general, Corps of Engineers, U. S. Army, has been appointed to take charge of the newly established army department of the Caribbean, to be known as the Department of Puerto Rico. General Daley, who now commands the First Coast Artillery District at Boston, Mass., will sail for San Juan, his new headquarters, in June.

ARTHUR T. IPPEN, a member of the civil engineering staff at Lehigh University has been promoted to the position of assistant professor of civil engineering at the university.

THOMAS J. MITCHELL, formerly in the U. S. Engineer Office at Pittsburgh, Pa., is now general superintendent of the Poinsett Lumbering and Manufacturing Company at Pickens, S.C.

RICHARD KING has become senior office assistant in the Texas State Highway Department, with headquarters at Brownwood, Tex.

PAUL J. CANNELL, who is on the staff of the Central Nebraska Public Power and Irrigation District, has been promoted from the position of designer to that of head of the design department, with the title of hydraulic engineer.

GROVER C. DILLMAN, president of the Michigan College of Mining and Technology, has been appointed to fill the recently vacated post of State Budget Director of Michigan. It is expceted that President Dillman will take a leave of absence from his present duties.

CLARENCE A. WILLSON, structural engineer in the Wisconsin State Architect's Office, has been elected president of the Engineering Society of Wisconsin for the coming year. Another member of the Society serving as an officer of this organization is JAMES L. FEREBEE, who has been elected vice-president. Mr. Ferebee is also Vice-President of the Society.

HUGER F. MARTIN, until recently sales engineer for the Rensselaer Valve Company, of Dallas, Tex., has accepted employment in a similar capacity with the International Filter Company in the same city.

JOHN W. WHEELER has resigned as assistant chief engineer of the Burlington Lines in order to accept the position of general manager of the Cities Construction Company, of Hammond, Ind.

PETER N. HEINTSKILL is now structural engineer for the Kimberly Clark Corporation at Kimberly, Wis.

ALLEN A. FUTRAL has been transferred from the 1st New Orleans District of the U. S. Engineer Office to the hydroelectric section of the Little Rock District.

THOMAS J. MORRISON, consulting engineer of Rochester, N.Y., has been appointed WPA engineer in charge of Niagara, Cattaraugus, Chautauqua, and adjoining counties in New York State.

RICHARD F. POSTON has joined the staff of the U. S. Public Health Service on stream pollution surveys at Chattanooga, Tenn. He was formerly sanitary engineer for the South Dakota State Board of Health.

L. H. Hewitt, captain, Corps of Engineers, U. S. Army, is being transferred from his present duty in the Philippines to assistant to the U. S. District Engineer of Galveston, Tex.

Kirpal Singh, formerly professor of mechanical engineering at Maclagan Engineering College, Lahore, India, is now principal of the Victoria Diamond Jubilee Hindu Technical Institute, at Lahore.

Herbert W. Witte has been transferred from the Water Resources Branch of the U. S. Geological Survey at Atlanta, Ga., to the U. S. Engineer Office at Huntington, W.Va.

W. P. Greenawalt has resigned as district manager of the Ingot Iron Railway Products Company, Chicago, Ill., to join J. L. Young in the partnership, Young and Greenawalt, with headquarters in Chicago. This firm will handle railroad supplies, general railway contracting, and engineering.

George H. Henderson was recently appointed deputy director and chief engineer of the Rhode Island State Department of Public Works. He was formerly consulting engineer for the New England division of the Koppers Products Company and, later, on special studies for the Connecticut Highway Department.

Irving L. Johnson has left the post of associate bridge engineer in the California State Division of Highways to join the sales staff of the Raymond Concrete Pile Company at Los Angeles.

T. C. Forrest, Jr., who recently withdrew from the civil engineering firm, Myers, Noyes, and Forrest, has established his own consulting practice at 817 Praetorian Building, Dallas, Tex.

DECEASED

Henry Bissell Alvord (M. '38) head of the department of civil engineering at Northeastern University, died in Boston, Mass., on April 20, 1939, at the age of 53. From 1907 to 1910 Professor Alvord taught at Massachusetts Institute of Technology, his alma mater, and from the latter year until 1914 at Bowdoin College. From 1914 to 1918 he was connected with the Aberthaw Consulting Company, and in 1920 he went to Northeastern University as professor of civil engineering in charge of the department.

Charles Slauson Boardman (M. '09) consulting engineer for the Carnegie-Illinois Steel Corporation at Pittsburgh, Pa., died at his home there on April 19, 1939, at the age of 65. In 1907 Mr. Boardman designed and patented a new type of interlocking steel piling, which was employed in raising the battleship *Maine* from Havana Harbor and was later in general use in construction work. At one time Mr. Boardman was chief engineer of the Lackawanna Steel Company, and for a number of years he was contracting engineer for the Jones and Laughlin Steel Corporation. About a year ago he became connected with the Carnegie-Illinois Steel Corporation.

Walter Carl Buetow (M. '30) of Milwaukee, Wis., died suddenly in that city on April 23, 1939, at the age of 54. For a time Mr. Buetow served as bridge engineer for the Chicago, Milwaukee and St. Paul Railroad. In 1911 he joined the staff of the Wisconsin State Highway Commission, resigning in 1924 to become chief engineer of the Stein Construction Company. From 1928 to 1931 he was state highway engineer. More recently Mr. Buetow was in the Milwaukee Public Works Department.

John Farris (M. '19) president of the Farris Engineering Company, Pittsburgh, Pa., died at Oakland, Pa., on April 15, 1939. He was 64. Soon after his graduation from the University of Wisconsin (1907) Mr. Farris, with an older brother, established a bridge construction practice in Pittsburgh. He was president of this firm from 1915 until his death. Mr. Farris was active in the work of the Pittsburgh Section, which he served as president.

Oliver Howard Horner (Assoc. M. '24) consulting engineer of Kansas City, Mo., died there on April 13, 1939, at the age of 50. From 1914 to 1918 Mr. Horner was assistant engineer for Black and Veatch, of Kansas City, and from 1919 to 1921 vice-president of the Sherman Engineering Company. In 1921 he became a partner in the engineering firm, Horner and Wyatt, and from 1935 on he was sole owner of this firm.

William H. Jackson (M. '23) president of the Pittsburgh-Des Moines Company, of Pittsburgh, Pa., died on April 26, 1939, at the age of 71. From 1893 to 1900 Mr. Jackson was a member of the civil engineering and contracting firm, Jackson and Moss, of Des Moines, Iowa. From the latter year on he was with the Des Moines Bridge and Iron Works, the name being changed in 1916 to the Pittsburgh-Des Moines Company. Mr. Jackson had served as president since 1921.

The Society welcomes additional biographical material to supplement these brief notes and to be available for use in the official memoirs for "Transactions."

Sir Henry Japp (M. '05) chief engineer and works director for John Mowlem and Company, Ltd., of London, England, died on April 8, 1939, at the age of 69. As manager of S. Pearson and Sons, Ltd., Sir Henry (then Henry Japp) had full charge of the work of driving tunnels under the East River (New York) for the Pennsylvania Railroad thirty years ago. This was one of many important projects on which he was engaged both here and abroad. During the war he was director of production for the British government, and it was for this service that he was knighted in 1918. He became chief engineer for John Mowlem and Company in 1915.

Henry Ambrose Larsen (Assoc. M. '13) Pacific Coast sales manager of the Wickwire Spencer Steel Company, San Francisco, Calif., died suddenly in that city on April 1, 1939. He was 54. Mr. Larsen's early career included steel design for numerous projects in California and Oregon. Later he was sales manager for L. A. Norris, of Los Angeles, and for several years Pacific Coast manager of the National Steel Fabric Company, of San Francisco. He became connected with the Wickwire Spencer Steel Company in 1935.

Harry Seymour McKibben (Assoc. M. '14) of Warren, Ohio, died on April 13, 1939, at the age of 66. Mr. McKibben's early career was devoted to teaching and to railroad location and construction. Later he was in charge of highway construction for Trumbull County (Ohio), and from 1909 to 1913 he was county engineer of Trumbull County, supervising all the engineering work of the county. He then established a general engineering and surveying practice in Warren.

Harrison Curtis Mower (M. '12) of Balboa Island, Calif., died at his home there on April 16, 1939, at the age of 64. Colonel Mower entered the U. S. Engineer Office in 1902 and remained there for a number of years. For a time he was manager of the Electrozone Water Sterilizer Company, at Alhambra, Calif. He then established an engineering and contracting practice in Los Angeles, from which he retired in 1934. Colonel Mower served in both the Spanish-American War and the World War.

Joseph Andrews Sargent (M. '30) supervising engineer for the PWA on the construction of Lincoln Tunnel until a recent illness forced his retirement, died in New York City on April 20, 1939. He was 66. Mr. Sargent was active in the construction of reclamation projects in South America, Cuba, and Europe. He was also engaged on many projects in this country, including the construction of the East River (New York) tunnels. From 1913 to 1917 he had charge of constructing the hydroelectric plant in the Pyrenees for the Ebro Irrigation and Power Company. This project included the construction of the largest dam and concrete-lined power canal in Europe at that time. During the war Mr. Sargent served as captain of the 2d Engineers, U. S. Army, and was awarded the Croix de Guerre.

Frank Charles Wolfe (M. '11) consulting engineer of Baltimore, Md., died recently at the age of 68. Mr. Wolfe's early career included considerable experience in railroad and bridge construction work. Beginning in 1909, he was for some time structural expert in charge of the office of D. B. Banks, consulting engineer of Baltimore. Later he was secretary and treasurer for B. F. Johnstone and Company of the same city, and he established his own consulting practice in 1935.

Changes in Membership Grades

Additions, Transfers, Reinstatements, and Resignations

From April 10 to May 9, 1939, Inclusive

Additions to Membership

Barber, Armour Gaylord (Assoc. M. '39), Field Engr., Sun Oil Co., 2117 National Bank Bldg. (Res., 11641 Mansfield), Detroit, Mich.

Bernhard, Rudolf Karl (M. '39), Prof. and Head, Dept. of Eng. Mechanics, Pennsylvania State Coll., State College, Pa.

Carrier, Ronald Henry (Assoc. M. '39), Chf. Structural Engr., Kumardhubi Eng. Works Ltd., Kumardhubi P. O., Dist. Manbhum, India.

Dohn, Charles Walter (Jun. '39), Timekeeper-Eng. Asst., Johnson, Drake & Piper, Inc., Freeport (Res., 57-03 Catalpa Ave., Ridgewood), N.Y.

Ehlers, Victor Marcus (M. '38), Director, Bureau of San. Eng., State Dept. of Health (Res., 2616 Rio Grande St.), Austin, Tex.

Freas, Alan D'Yarmett (Jun. '39), Instr. in Ry. Eng., Univ. of Wisconsin, Eng. Bldg., Univ. of Wisconsin (Res., 2521 Kendall Ave.), Madison, Wis.

Garrity, Leo Valentine (Assoc. M. '39), Associate Civ. Engr., City of Detroit, 9644 West Jefferson Ave. (Res., 14631 Mark Twain Ave.), Detroit, Mich.

Glynn, Desmond Ford (Jun. '39), Eng. Draftsman, Melbourne and Met. Board of Works, "Maralyn," Olevitte Ave., Upwey, Victoria, Australia.

Griffiths, William Henry, Jr. (Jun. '38), Soils Laboratory Asst., State Highway and Public Works Comm. (Res., 1020 West Peace St., Apartment L-6), Raleigh, N.C.

Hamner, Bennett Barron (Jun. '38), Box 1151, Tyler, Tex.

Hansen, Fay Nelson (Assoc. M. '39), Asst. Engr., U. S. Geological Survey, 641 Federal Bldg., Louisville, Ky.

Harker, Herbert Weese (Jun. '38), 642 Fourth St., Niagara Falls, N.Y.

Hoffman, Arthur Aaron (Jun. '39), Engr., Golden Gate Iron Works, 1541 Howard St., San Francisco, Calif.

Keating, Charles Stanley (M. '39), Cons. Engr., City of Syracuse, 400 City Hall, Syracuse, N.Y.

Kendrick, Harry Deckard (Assoc. M. '39) Res. Engr., PWA, Box 242, Norfolk, Nebr.

King, William Byrd, III (Jun. '38), Estimator, Designer, and Detailer, Fort Worth Structural Steel Co. (Res., 1005 Poindexter St.), Fort Worth, Tex.

Knight, Allan Walton (Assoc. M. '39), Chf. Engr., Public Works Dept., Hobart, Tasmania, Australia.

Kukuk, Clifton Carrol (Jun. '38), Junior Engr., Bureau of Reclamation, Pierre, S.Dak.

Lockett, John Bolling (Jun. '39), Junior Civ. Engr., Div. Engr. Office, Upper Mississippi Val. Div., Corps of Engrs., U.S.A., 831 U. S. Court House and Custom House, St. Louis, Mo.

Loehr, John Jacob (M. '39), Designing Engr.-Acting Chf. Engr., Commrs. of Sewerage, 400 M. E. Taylor Bldg., Louisville, Ky.

MacKay, Harry Fraser (Jun. '39), Engr., U. S. Forest Service, Columbia National Forest, Box 60, Vancouver, Wash. (Res., 3165 North Willamette Boulevard, Portland, Ore.)

McDonald, Norman Geddes (M. '39), Cons. Engr. (Gore & Storrie), 1130 Bay St., Toronto, Ont., Canada.

McKinnon, DeMar John (Jun. '38), Fort Washakie, Wyo.

Meehan, Joseph Aloysius (M. '39), Acting Chf. Engr., Dept. of Docks, New York City, Pier A, North River (Res., 3355 Olinville Ave.), New York, N.Y.

Osborn, Eugene Wallace (Jun. '38), With Bagg & Newkirk, 258 Genesee St., Utica (Res., 161 Todt Hill Rd., Staten Island), N.Y.

Osborn, Hugh (Assoc. M. '39), Asst. Civ. Engr., AAA, Aerial Mapping, 2321 West End Ave. (Res., Stokes Lane), Nashville, Tenn.

Owings, Noble Lewis (Assoc. M. '39), Asst. to Chf. Engr., Washington Suburban San. Dist., Hyattsville (Res., 109 Washington Ave., Riverdale), Md.

Peletz, Harold (Jun. '39), Asst. Supt., L. S. Peletz, 1660 West Acacia St., Stockton, Calif.

Phillips, George Wendell (Assoc. M. '39), Div. Engr., State Highway Dept., Grove Hill (Res., Thomasville), Ala.

Prusas, Victor Joseph (Jun. '39), Junior Engr., North Am. Aviation, Inc., 1803 South Highland Ave., Los Angeles, Calif.

Reichmann, Paul Adolph (Jun. '39), 602 West 188th St., New York, N.Y.

Shultz, Richard Paul (Jun. '38), With U. S. Engr. Office (Res., 2417 Clifton Ave.), Cincinnati, Ohio.

Skinner, Howard Edward (Jun. '39), Junior Topographic Engr., U. S. Geological Survey, Box 346, Sacramento, Calif.

Smith, Waldo Woodrow (Jun. '39), Estimator-Structural Engr., The James H. Tower Iron Works, 50 Borden St. (Res., 268 Massachusetts Ave.), Providence, R.I.

Thomas, Henry Hardstaff (Jun. '39), Asst. Engr., Hydr. Designs, Hydro-Elec. Comm., Hobart, Tasmania, Australia.

Tobin, Robert Emmett (Jun. '38), Eng. Experiment Station, Iowa State Coll., Ames, Iowa.

Wallace, John Albert (M. '39), Senior Grade Separation Engr., State Dept. of Public Works, State Office Bldg. (Res., 212 Lancaster St.), Albany, N.Y.

Woodrich, Warren Brown (Jun. '39), Care, Woodrich Constr. Co., 613 National Bldg., Minneapolis, Minn.

Membership Transfers

Anderson, John Gordon (Jun. '29; Assoc. M. '39), Asst. Structural Engr., U. S. Bureau of Reclamation, U. S. Customs House (Res., 1226 Dexter St.), Denver, Colo.

Buerkle, Herbert Cosmos (Jun. '32; Assoc. M. '38), Asst. Civ. Engr., Essex County Highway Dept. (Res., 37 Sunset Ave.), Newark, N.J.

Carden, Leo Franklin (Jun. '30; Assoc. M. '38), Asst. Agr. Engr., SCS, Box 668, Farmington, N.Mex.

Carpenter, Samuel Theodore (Jun. '30; Assoc. M. '39), Asst. Prof., Civ. Eng., Swarthmore Coll., Swarthmore, Pa.

Castelazo, Arthur Harrold (Jun. '28; Assoc. M. '39), Asst. to Contract Supt., U. S. Navy Yard, Mare Island (Res., 400 Central Ave., Vallejo), Calif.

Courter, John Wayne (Jun. '28; Assoc. M. '39), Project Engr., U. S. Bureau of Public Roads, Yellowstone Park, Wyo.

Dodge, Russell Alger (Assoc. M. '26; M. '39), Associate Prof., Eng. Mechanics, Univ. of Michigan, 411 West Eng. Bldg., Univ. of Michigan, Ann Arbor, Mich.

Finlay, Sam (Jun. '28; Assoc. M. '39), Hydr. Engr., Michigan Northern Power Co., Glen Ferris, W.Va.

Harton, Thomas Gordon (Jun. '34; Assoc. M. '39), Associate Engr., TVA, 605 Union Bldg., Knoxville, Tenn.

Johnson, Max Roland (Jun. '30; Assoc. M. '39), Asst. Engr., U. S. Bureau of Reclamation, Old High School Bldg. (Res., 905 C St.), Antioch, Calif.

Ketchum, Milo Smith, Jr. (Jun. '31; Assoc. M. '39), Asst. Prof., Structural Eng., Case School of Applied Science, University Circle, Cleveland, Ohio.

Leupold, Norbert Herman (Jun. '30; Assoc. M. '39), Asst. Engr., U. S. Engr., 500 Pittock Blk. (Res., 502 South East 69th Ave.), Portland, Ore.

Mitchell, Lester Morris (Assoc. M. '25; M. '39), Vice-Pres., Merritt-Chapman & Scott Corporation, 17 Battery Pl., New York, N.Y.

Rappleye, Howard Snyder (Assoc. M. '28; M. '39), Mathematician, U. S. Coast and Geodetic Survey, Room 2102, Commerce Bldg., Washington, D.C.

Rollins, John Martin (Jun. '26; Assoc. M. '39), Field Representative, Ethyl Gasoline Corporation, 2821 Arbor, Houston, Tex.

Seeman, Lyle Edward (Jun. '34; Assoc. M. '39), Capt., Corps of Engrs., U.S.A., Military Dept., Ohio State Univ., Columbus, Ohio.

Shattuck, Walter Francis, Jr. (Jun. '28; Assoc. M. '39), Cons. Engr., 221 North La Salle St., Chicago (Res., 528 Warwick Rd., Kenilworth), Ill.

Stephens, Charles Henry (Jun. '30; Assoc. M. '39), Asst. Engr., Dept. of Water, City of Dayton, 308 U. B. Annex (Res., 79 West Norman Ave.), Dayton, Ohio.

Thieme, Fred Ernest (Assoc. M. '28; M. '39), Asst. Regional Forester, U. S. Forest Service, Federal Bldg. (Res., 403 Evans Ave.), Missoula, Mont.

Wagner, Clifton James (Jun. '27; Assoc. M. '39), Lieut. (jg), U. S. Coast and Geodetic Survey, Municipal Terminal 4, St. Johns Station, Portland, Ore.

Wentworth, Winslow Clarence (Jun. '29; Assoc. M. '39), Engr., Hydr. Eng. Dept., Turners Falls Power & Elec. Co., Ave. A, Turners Falls (Res., 48 Shattuck St., Greenfield), Mass.

Young, Lewis Alaric (Jun. '35; Assoc. M. '39), Asst. Engr., State Board of Health, Div. of Sanitation, Room 2, Marvin Hall, Univ. of Kansas, Lawrence, Kans.

Reinstatements

Ammerman, Hub Turner, Assoc. M., reinstated Apr. 19, 1939.

Bailey, Frank Sawin, Assoc. M., reinstated May 5, 1939.

Keasbey, Howard Buzby, Assoc. M., reinstated Apr. 20, 1939.

Resignations

Brown, Charles Vines, Jr., Jun., resigned Apr. 14, 1939.

Cleveland, Malcolm Colburn, M., resigned Apr. 7, 1939.

Conole, Clement Vincent, Jun., resigned May 3, 1939.

Fahrenkrog, Eugene Henry, Jun., resigned Apr. 10, 1939.

Iandolo, Jeremiah Constantine, Jun., resigned May 3, 1939.

Johnson, Wayne Pfost, Jun., resigned Apr. 10, 1939.

O'Neall, Albert Ellis, Jun., resigned May 4, 1939.

Rowland, John Harvey, Assoc. M., resigned Apr. 10, 1939.

Swanton, Walter Frederick, Jun., resigned Apr. 19, 1939.

Wagner, John, Jr., Assoc. M., resigned May 3, 1939.

White, George Clifford, Jun., resigned May 4, 1939.

TOTAL MEMBERSHIP AS OF MAY 9, 1939

Members	5,639
Associate Members	6,367
Corporate Members	12,006
Honorary Members	27
Juniors	3,960
Affiliates	74
Fellows	1
Total	16,068

Applications for Admission or Transfer

Condensed Records to Facilitate Comment from Members to Board of Direction

June 1, 1939 — Number 6

The Constitution provides that the Board of Direction shall elect or reject all applicants for admission or for transfer. In order to determine justly the eligibility of each candidate, the Board must depend largely upon the membership for information.

Every member is urged, therefore, to scan carefully the list of candidates published each month in Civil Engineering *and to furnish the Board with data which may aid in determining the eligibility of any applicant.*

It is especially urged that a definite recommendation as to the proper grading be given in each case, inasmuch as the grading must be based upon the opinions of those who know the applicant personally as well as upon the nature and extent of his professional experience. Any facts derogatory to the personal character or professional reputation of an applicant should be promptly communicated to the Board.

Communications relating to applicants are considered strictly confidential.

The Board of Direction will not consider the applications herein contained from residents of North America until the expiration of 30 days, and from non-residents of North America until the expiration of 90 days from the date of this list.

MINIMUM REQUIREMENTS FOR ADMISSION

Grade	General Requirement	Age	Length of Active Practice	Responsible Charge of Work
Member	Qualified to design as well as to direct important work	35 years	12 years	5 years RCM*
Associate Member	Qualified to direct work	27 years	8 years	1 year RCA*
Junior	Qualified for sub-professional work	20 years	4 years	
Affiliate	Qualified by scientific acquirements or practical experience to cooperate with engineers	35 years	12 years	5 years RCM*

* In the following list RCA (responsible charge—Associate Member standard) denotes years of responsible charge of work as principal or subordinate, and RCM (responsible charge—Member standard) denotes years of responsible charge of IMPORTANT work, i. e., work of considerable magnitude or considerable complexity.

FOR MEMBER

Ames, Oliver Russell, Wilmington, Del. (Age 42) (Claims RCA 1.9 RCM 9.0) Sept. 1928 to date with E. I. du Pont de Nemours & Co. as Asst. Engr., Asst. Constr. Supt., Constr. Supt., and (since Nov. 1938) Asst. Mgr., Constr. Div., Eng. Dept.

Anderson, Robert Leo, Arlington, Va. (Age 41) (Claims RCA 7.5 RCM 6.0) Feb. 1931 to date with Bureau of Yards and Docks, Navy Dept., Washington, D.C., as Associate Structural Engr., and (since Jan. 1939) Structural Engr., on design of many reinforced concrete and structural steel structures, etc.

Andrews, Harry Samuel, Fulton, N.Y. (Age 49) (Claims RC 8.7 D 7.7) Jan. 1938 to date Res. Engr. with Glenn D. Holmes, Cons. Engr., Syracuse, N.Y.; Sept. 1923 to Jan. 1938 City Engr. and Commr., Public Works, Fulton.

Barber, DeLoss Harold (Assoc. M.), Montgomery, Ala. (Age 44) (Claims RC 16.7 D 6.1) April 1925 to date with U. S. Geological Survey as Jun. Engr., Asst. Engr., Associate Engr., and (since Sept. 1934) Dist Engr.

Batson, Benjamin Arthur (Assoc. M.), Cincinnati, Ohio. (Age 38) (Claims RCA 5.7 RCM 6.9) Jan. 1937 to date member of firm, Carlton, Frankenberger & Batson, Engrs. and Archts.; Associate Engr., Carlton & Kennedy; Associate Civ. Engr., TVA.

Becker, Donald Neil, Chicago, Ill. (Age 51) (Claims RCA 6.0 RCM 14.6) March 1912 to Sept. 1924 Bridge Designing Engr., and Sept. 1924 to date Engr. of Bridge Design, Bridge Div., City of Chicago.

Cohn, Morris Mandel (Assoc. M.), Schenectady, N.Y. (Age 40) (Claims RCA 6.8 RCM 11.2) Jan. 1938 to date San. and Testing Engr., Dept. of Eng. and Public Works; 1933 to date Cons. San. Engr., Gen. Elec. Co., Schenectady and Cleveland, Ohio, etc.

Gott, Laurance Edward, Los Angeles, Calif. (Age 45) (Claims RCA 9.9 RCM 12.4) July 1924 to date with Bureau of Water-Works & Supply as Topographical Draftsman, Chf. Draftsman, Asst. Civ. Engr.; and (since Jan. 1939) Engr.-in-Charge, Distribution, Constr. and Operation Div., responsible to Chf. Engr. and Asst. Chf. Engr. of Bureau.

Harsch, Erwin (Assoc. M.), Chattanooga, Tenn. (Age 44) (Claims RCA 10.5 RCM 5.7) Aug. 1933 to date Senior Highway Bridge Engr., TVA.

Hopkins, Elmer Woodson, Salina, Kans. (Age 46) (Claims RCA 8.1 RCM 13.4) Nov. 1936 to date City Engr., on general municipal engineering; previously with Black & Veatch, Cons. Engrs., Kansas City, Mo., on engineering design, plans, estimates and appraisals, etc.

Howat, Philip Yvone Kirkpatrick (Assoc. M.), Baltimore, Md. (Age 47) (Claims RCA 8.1 RCM 17.2) July 1938 to date Pres. and Mgr., Howat Concrete Co., Inc.; July 1930 to 1938 with Roberts Paving Co., Salisbury, Md., 2 years as Asst. Gen. Mgr. estimating, buying and managing; since 1932 Mgr., Capital Materials Co., Washington, D.C. (organized by R. P. Co.).

Ingersoll, Harold Barrett, Cartersville, Ga. (Age 45) (Claims RCA 2.0 RCM 11.4) Aug. 1938 to date Asst. Civ. Engr., Flood Control Surveys, Little Tallahatchie, Miss., and Coosa, Ga.; Aug. 1936 to Aug. 1938 Senior Eng. Draftsman, Soil Conservation Service, Spartanburg, S.C.; previously Jun. Engr., U. S. Forest Service.

Johnson, LeRoy Francis (Assoc. M.), Concord, N.H. (Age 43) (Claims RC 19.7 D 19.7) April 1919 to date with New Hampshire State Highway Dept. as Draftsman, Recorder, Transitman, Chf. of Survey Party, Asst. Div. Engr., Div. Engr., and (since Feb. 1934) Maintenance Engr., responsible for maintenance of state highway system.

McFarland, Frank Ray, Kansas City, Mo. (Age 44) (Claims RCA 1.0 RCM 17.0) 1924 to date Supt. of Constr., Sheffield Steel Corporation, on railway work, including 6 miles of switch tracks, one-half mile of elevated tracks, pile trestles and bridge foundations, etc.

Murray, Howard Slater (Assoc. M.) Los Angeles, Calif. (Age 40) (Claims RCA 0.4 RCM 15.2) April 1935 to date Pres. and Chf. Engr., Uniflow Pump Co., being Engr. in charge of all designs, research, construction and tests on large rotary pumps for pumping concrete; previously Structural Engr., Six Companies, Inc., Boulder City, Nev.

Paul, Frederick Thornton, Minneapolis, Minn. (Age 55) (Claims RCA 11.8 RCM 16.4) Nov. 1919 to date with City of Minneapolis as Asst. Paving Engr., 1st Asst. City Engr. in charge of Bridge and Paving Depts., and (since Jan. 1933) City Engr. in complete charge of all public works, including water works, design and construction.

Savelle, Morton Judson, Auburn, Ala. (Age 51) (Claims RC 14.6 D 11.5) Aug. 1935 to Oct. 1937 Staff Engr., and Oct. 1937 to date Director, WPA, since Oct. 1937 on geodetic control survey project; previously Field Director, Ala.RA, in charge of all construction in eleven counties.

Voorhies, Louis Joseph, Baton Rouge, La. (Age 52) (Claims RCA 4.8 RCM 21.9) Oct. 1926 to date Cons. Engr., designing and supervising construction of water-works and sanitary sewerage sytems, etc.

Wicker, Carlton Scott, Buffalo, N.Y. (Age 49) (Claims RC 24.8 D 0.9) Nov. 1919 to May 1928 Sales Engr., and May 1928 to date Sales Mgr., The Buffalo Slag Co., on sales, designs and specifications, highway, railroad, building and concrete construction.

FOR ASSOCIATE MEMBER

Abell, Julian David (Junior), Corozal, Canal Zone. (Age 32) (Claims RCA 2.3 RCM 0.0) July 1937 to date 1st Lieut., 11th Engrs.; March 1933 to July 1935 Res. Engr., Lower Detroit River, being Asst. to Dist. Engr., U. S. Engrs., Detroit, Mich.; in the interim graduate student.

Arneberg, Birger Haaversen, Knoxville, Tenn. (Age 46) (Claims RCA 6.4 RCM 5.7) June 1936 to date with TVA as Asst. Engr., and (since Jan. 1937) Associate Engr., Eng. Design Dept.; previously with WPA, Office of Cons. Engr., Borough Pres. of Richmond, Design Div., on reinforced concrete design, planning and directing design of various projects.

Atchison, James Edward, Cleveland, Ohio. (Age 37) (Claims RCA 0.5 RCM 11.8) Jan. 1933 to date Chf. Draftsman, Iron Fireman Mfg. Co., applying automatic coal stokers to heating and industrial power boilers, etc.

Bacci, Joseph Albert, Rock Island, Ill. (Age 27) (Claims RCA 2.9 RCM 0.0) Oct. 1938 to date Asst. Res. Engr. Inspector, FPWA, on construction of sewers and treatment plant; previously Topographic Draftsman, The Chicago Park Dist.; Field Engr. with The Austin Co., Republic Steel Corporation, and Herilhy Mid-Continent Co., all of Chicago; Jun. Highway Engr., Illinois Div. of Highways, Dist. No. 4, Peoria, Ill.

Benedict, Paul Charles (Junior), Boise, Idaho. (Age 32) (Claims RCA 4.5 RCM 0.5) April 1930 to date with U. S. Geological Survey as Jun. Engr., Asst. Engr., and (since Dec. 1938) Res. Engr., in charge under Dist. Engr., Boise River Silt Investigation.

Burley, Fred Harvey, Detroit, Mich. (Age 36) (Claims RCA 5.0 RCM 5.2) March 1936 to date Res. Engr., Detroit Dept. of Public Works, sewage disposal plant project, having responsible charge of major construction contracts; previously with Ford Motor Co., Jacksonville, engineering and constructing plant.

Calvert, William Nelson, Jr., Chattanooga, Tenn. (Age 32) (Claims RCA 3.1 RCM 1.0) July 1933 to date with TVA as Prin. Eng. Draftsman, Asst. Highway Engr., and (since July 1937) Associate Highway Engr. responsible for design of work, etc.

Carhart, Rufus Chamberlain, Austin, Tex. (Age 27) (Claims RCA 2.9 RCM 0.0) June 1932 to date with Texas State Highway Dept. as Asst. Concrete Plant Inspector, and Asst. Bridge Inspector, Concrete Plant Inspector, Bridge Inspector, Asst. Res. Engr., Asst. Engr., and (since Jan. 1939) Jun. Designing Engr.

Carlson, Carl Harold (Junior), Des Moines, Iowa. (Age 32) (Claims RC 5.8 D 2.5) Oct. 1936 to date Constr. Engr., The Weitz Co.,

Inc., Gen. Contrs.; May 1935 to Oct. 1936 intermittently with various architects; previously Administrator, Rural Polk County, Iowa, CWA.

CASE, JOHN GIDEON (Junior), San Marino, Calif. (Age 32) (Claims RCA 6.6 RCM 1.1) Nov. 1935 to date Structural Designer, Structural Eng. Associate, Structural Engr., and Senior Structural Engr. for various companies, including Austin & Ashley, Bethlehem Steel Co., Marsh, Smith & Powell.

CENTOLA, GIUSEPPE, Rome, Italy. (Age 34) (Claims RCA 5.9 RCM 0.0) Sept. 1932 to date with Royal Automobile Club of Italy as Engr. and Chf. Engr. for Highways and Traffic Technical Dept., and (since Jan. 1935) Mgr., Technical Dept., supervising building of branch offices and headquarters, etc.

CORRADI, PETER (Junior), White Plains, N.Y. (Age 28) (Claims RCA 3.7 RCM 0.0) Dec. 1938 to date Engr. Inspector, Board of Water Supply, City of New York; previously Draftsman, Design Div., Port of New York Authority; Senior Draftsman, War Dept., Engr. Corps, U. S. Army; Draftsman, Triborough Bridge Authority, New York City.

DYER, WESLEY HALLIBURTON (Junior), Nashville, Tenn. (Age 31) (Claims RCA 4.6 RCM 0.0) Jan. 1931 to date with Nashville (Tenn.) Bridge Co. as Field Engr., Draftsman, Sales Engr., Res. Engr., Estimator, and (since Sept. 1935) Structural Sales Engr.

EBERHART, HOWARD DAVIS (Junior) Berkeley, Calif. (Age 32) (Claims RCA 1.8 RCM 0.0) Aug. 1936 to date Instructor in Civ. Eng., Eng. Materials Laboratory, Univ. of California; previously with U. S. Army Engrs., Bonneville Dam Sec.

FINK, GEORGE ROBERT, Urbana, Ill. (Age 29) (Claims RCA 2.2 RCM 0.7) June 1938 to date Designing Structural Engr., successively with Vonnegut and Bohn, and Russ and Harrison, Archts.; Sept. 1936 to June 1938 Instructor, Univ. of Illinois.

FINNEY, EDWIN ASHLEY, East Lansing, Mich. (Age 40) (Claims RC 10.6) July 1937 to date Asst. Research and Testing Engr., Michigan State Highway Dept.; previously Instructor and Asst. Prof., of Civ. Eng., Michigan State Coll.

FISCHER, VICTOR WILLIAM (Junior), New York City. (Age 32) (Claims RCA 3.0 RCM 0.0) Oct. 1928 to date with New York Central R.R. as Chainman, Transitman, Chf. Transitman, and (since Aug. 1929) Party Chf, responsible for surveys, layouts, plots and designs, on railroad maintenance, etc.

GOFSEYEFF, SAMUEL (Junior), Brooklyn, N.Y. (Age 32) (Claims RCA 2.4 RCM 0.0) Dec. 1936 to date Jun. Engr., U. S. Engr. Office, Pittsburgh and New York City Dists., previously Transitman and Draftsman, Dept. of Parks, Brooklyn Topographical Div.

HANLON WILLIAM BURNS (Junior), Kingston, N.Y. (Age 30) (Claims RC 5.7) July 1930 to date with U. S. Geological Survey, Water Resources Branch as Jun. Engr., Asst. Engr., and (since April 1938) Associate Engr.

HATFIELD, ROBERT JOHN, Alhambra, Calif. (Age 36) (Claims RCA 7.1 RCM 0.0) March 1928 to date with California Div. of Highways as Instrumentman, Chf. of Survey Party, Asst. Res. Engr., Asst., and (since March 1932) Res. Engr.

HELLAND, RANDOLPH OLAF, Washington, D.C. (Age 53) (Claims RCA 5.1 RCM 0.0) June 1924 to date with U. S. Geological Survey, Water and Power Div., Conservation Branch as Asst. Classifier, Asst. Scientist, and (since March 1931) Associate Engr.

HERTZLER, RICHARD ADIN, (Junior), Asheville, N.C. (Age 32) (Claims RCA 6.6 RCM 1.9) Sept. 1934 to date Supt., Coweeta Experimental Forest, U. S. Forest Service, Appalachian Forest Experiment Station; previously Road Foreman, Commonwealth of Pennsylvania, Dept. of Military Affairs.

HJORTH, EVERETT WASHINGTON, North Hollywood, Calif. (Age 32) (Claims RCA 3.7 RCM 0.0) Aug. 1935 to date with Gen. Petroleum Corporation of California as Eng. Draftsman, Computer, and (since Jan. 1939) Asst. Chf. Draftsman on geological and land drafting and computing; previously Field Office Engr. with Los Angeles Dept. of Water and Power, Mono Basin Project, Laboratory Asst., U. S. Dept. of Agriculture, Eng. Div.

IVERS, WILLIAM JOSEPH (Junior), Cincinnati, Ohio. (Age 32) (Claims RCA 3.1 RCM 0.0) March 1939 to date Asst. Structural Engr., U. S. Engrs., War Dept.; Jan. to Nov. 1938 Structural Engr., F. H. McGraw Co., Middletown, Ohio; April 1927 to Jan. 1938 and Nov. 1938 to March 1939 with Div. of Highways, City of Cincinnati as Jun. Eng. Aide, Jun. Structural Engr., Asst. Structural Engr., and Designing Engr.

KALINSKE, ANTO ADAM, Iowa City, Iowa. (Age 27) (Claims RCA 2.8 RCM 0.5) Sept. 1936 to date Research Engr. and Instructor, Iowa Inst. for Hydr. Research, State Univ. of Iowa, supervising and conducting research work and preparing reports and papers, etc.; previously with Univ. of Wisconsin as Research Asst. and Research Fellow in Hydr. and San. Eng.

LA VALLE, EMERY ALPHONSE, San Francisco, Calif. (Age 56) (Claims RCA 26.4 RCM 0.0) Oct. 1938 to date Landscape and Designing Engr., San Francisco Housing Authority; previously Asst. Chf. and Landscape Engr., Bureau of Horticulture, Golden Gate International Exposition; previously in private practice as Landscape Engr.

MACCLOSKY, CHARLES CONRAD, Albany, N.Y. (Age 32) (Claims RC 10.1 D 2.8) 1928 to date with New York State Dept. of Public Works on design and construction of various bridges, etc., and (winters)on road design.

MCDONALD, ALFRED TURNER, Atlanta, Ga. (Age 31) (Claims RCA 7.2 RCM 2.5) Dec. 1936 to date Asst. County Engr., Fulton County, in charge of WPA work, involving design, specifications and supervision of construction of bridges, etc.; previously State Supervisor of triangulation and astronomical work, U. S. Coast & Geodetic Survey; Chf. of Party with I. U. Kauffman.

MCLEAN, RALPH STEWART (Junior), Brea, Calif. (Age 32) (Claims RC 5.8 D 2.3) March 1937 to date City Engr.; during same period various short engagements for other employers, previously Structural Designer for J. H. Davies and E. A. Ames; Observer, California Strong Motion Seismological Program, U. S. Coast and Geodetic Survey.

MARTIN, GEORGE NELSON, Oakland, Calif. (Age 32) (Claims RCA 5.7 RCM 0.0) Oct. 1929 to Jan. 1931, March to Nov. 1931 and Feb. 1933 to date with Bates & Rogers Constr. Co. as Asst. Engr., and (since May 1937) Asst. Supt.; in the interim Levelman, Delaware & Hudson R.R.

MARTIN, ROBERT EMMETT, Middlesboro, Ky. (Age 31) (Claims RC 7.7 D 7.7) Sept. 1936 to date Chf. Engr., Louisville Memorial Park, Shivly, Ky.; also, March 1938 to Jan. 1939 Jun. Engr., Kentucky State Dept. of Highways, and since Jan. 1939 Res. Engr., J. S. Watkins, Cons. Engr., Lexington, Ky., on Middlesboro (Ky.) sewer system; previously Engr., Jefferson County Road Dept.

MILLER, PHILIP SAMUEL, Kerhonkson, N.Y. (Age 29) (Claims RCA 4.2 RCM 0.0) March 1939 to date Safety Engr. and Designer, Samuel Rosoff, Ltd., New York City; previously Asst. Engr., Brader Constr. Corporation, New York City; Shaft Engr., and Designer, Rosoff Tunnel Co.; Estimator and Designer, Rosoff Subway Co.; Technical Writer, *World Petroleum*, New York City.

MILNAMOW, ARTHUR (Junior), Collingswood, N.J. (Age 32) (Claims RCA 1.0 RCM 4.2) Feb. 1939 to date Structural Engr., Louis T. Klauder and Associates, Philadelphia, Pa.; Oct. 1933 to Jan. 1939 Structural Engr. with various Cons. Engrs., and Delaware River Joint Comm.

MONEYMAKER, BERLEN CLIFFORD, Knoxville, Tenn. (Age 34) (Claims RCA 6.0 RCM 0.0) Dec. 1933 to date with TVA as Geologist, Asst. Geologist, and Associate Geologist, part of time acting Field Asst. and Asst. Chf.

MORTOLA, ALEXIS JOSEPH (Junior), Kew Gardens, N.Y. (Age 33) (Claims RCA 2.0 RCM 0.0) Dec. 1938 to date Transitman, Grade 4, Topographical Bureau, Borough Pres. of Queens; previously Eng. Asst. (T.C.), New York City Tunnel Authority; with Board of Transportation, N.Y. City as Station Agent and Asst. Station Supervisor, Independent Subway System.

OBERMANN, ROBERT FRANK (Junior), Jamaica, N.Y. (Age 32) (Claims RCA 10.7 RCM 0.0) Jan. 1936 to date Plant Engr., Jamaica (L.I.) Water Supply Co.; previously Field Engr. and Inspector with Sanborn & Bogert Cons. Engrs. (6 months), and Field Engr., U. S. Coast & Geodetic Survey Dept., Bergen County, N.J. (4 months), with Palisade Interstate Park Comm. of New Jersey, etc.

QUINONES CASTRO, MIGUEL ANGEL, Ponce, Puerto Rico (Age 30) (Claims RC 4.6 D 2.1) Oct. 1935 to date with Rural Electrification Div., Puerto Rico RA as Senior Asst. Civ. Engr., and (since May 1937) Associate Hydr. Engr. on hydraulic studies and structural designs for intakes, turbines, canals, etc.; previously Engr., Work Div., Design and Planning Dept. Puerto Rican ERA.

REBER, RUDOLPH CARL, Belle, W.Va. (Age 33) (Claims RCA 10.1 RCM 0.0) Oct. 1926 to date with E. I. duPont Co. as Instrumentman, Jun. Engr., Engr., Asst. Constr. Supt., and (since May 1933) Constr. Supt.

RIEDEL, CARL MARTIN, Chicago, Ill. (Age 47) (Claims RCA 10.0 RCM 4.0) July 1925 to date Designing Engr., Bureau of Eng., City of Chicago.

ROSA, JOSEPH JOHN (Junior), New Orleans, La. (Age 32) (Claims RCA 2.6 RCM 0.0) May 1934 to date with U. S. Engrs., on Lower Mississippi River Flood Control as Asst. Draftsman, Draftsman, and (since Jan. 1937) Jun. Civ. Engr.

SCHEER, HENRY OLIVER (Junior), Springfield, Ill. (Age 32) (Claims RC 4.0) June 1930 to date Jun. Engr., Illinois Div. of Highways as Draftsman and Inspector (1 year) and Maintenance Field Engr., etc.

SPARKS, ROBERTS RICHARDSON, Catonsville, Md. (Age 30) (Claims RCA 6.1 RCM 0.0) Aug. 1928 to date Engr., The Empire Constr. Co., on field layout work, quantity surveys and design, compiling bids and estimates, etc.

STREETER, ROBERT LEROY, Gillette, Wyo. (Age 29) (Claims RC 5.0 D 2.3) Jan. 1939 to date County Engr. and City Engr.; previously County Surveyor or Engr. and City Engr.

STRUVE, OTTO ERNEST, JR., Yonkers, N.Y. (Age 31) (Claims RCA 3.0 RCM 0.8) Feb. to April 1929 and June 1929 to date with U. S. Engr. Office as Sub-Surveyman, Surveyman, Senior Computer, and (since June 1937) Jun. Engr., being Asst. in charge of Design Sec., New York Dist.; in the interim Draftsman, R. H. Hoe & Co.

VINTON, SAMUEL SPENCER, JR., Richmond Heights, Mo. (Age 37) (Claims RCA 3.1 RCM 0.0) Feb. 1931 to date with U. S. Engr. Office, St. Louis, Mo. as Inspector, Student Engr., and (since May 1934) Jun. Engr.

VOCKROTH, JOHN HENRY (Junior), Dunmore, Pa. (Age 29) (Claims RCA 6.5 RCM 2.7) 1939 to date Asst. County Engr., Lackawanna County, Scranton; 1937 to 1939 Detailing and Designing Draftsman and Designer, with Anthracite Bridge Co.; also in private practice involving surveys, design of buildings, supervision of construction, etc. previously with WPA, Dist. No. 1, Scranton, as Administrative Asst., Estimator, Engr., Res. Engr. in Wayne and Pike Counties, Pa., and Project Engr. and Gen. Foreman.

VON HOLTEN, HERMAN JOHN WILLIAM, White Plains, N.Y. (Age 34) (Claims RCA 9.8 RCM 0.0) Oct. 1931 to date with Board of Water Supply, New York City, since Sept. 1938 having charge of part of sanitary control operations at 15 shaft sites.

WALLACE, WILLIAM, London, S.W.I., England. (Age 32) (Claims RC 7.2 D 4.5) Oct. 1929 to Jan. 1932 and July 1936 to date Asst. Engr., Tanganyika Govt. Rys.; in the interim Asst. Engr., Sir Alexander Gibb & Partners, Cons. Engrs., Westminster.

WARNER, ROY FERDINAND (Junior), Iowa City, Iowa. (Age 32) (Claims RCA 4.5 RCM 0.5) Nov. 1933 to date with Corps of Engrs., U. S. Army, St. Paul, Minn. as Surveyman and Engr. Aide, Jun. Engr. and Asst. Engr. acting as Research Asst. on hydraulic model tests, preparing reports, directing research work, etc.

WHITMAN, NATHAN DAVIS, JR. (Junior), Alhambra, Calif. (Age 30) (Claims RCA 3.0 RCM 0.5) Sept. 1936 to date Design Engr., Quinton, Code & Hill-Leeds & Barnard; previously Structural Design Engr., under supervision of O. G. Bowen; Jun. Soil Conservationist, U. S. Dept. of Agriculture, Soil Conservation Laboratory; Jun. Bridge Design Engr., San Francisco–Oakland Bay Bridge.

FOR JUNIOR

ACKERBLOOM, THURSTON ROBERT, Astoria, N.Y. (Age 23) (Claims RC 1.3) June 1937 to date with Madden & Lane, Inc. as Transitman, Chf. of Party supervising field engineering, and (since Oct. 1938) Supt. of Constr.

BROOKHART, GEORGE CLINTON, White Plains, Md. (Age 21) 1938 B.S. in Civ. Eng., Univ. of Md.; July 1938 to date with J. E. Greiner Co., Cons. Engrs. as Instrumentman, acting as Chf. of Party, and (since Oct. 1938) Instrumentman and Engr. on Potomac River Bridge, etc.

CLAPSADDLE, JACK LINCOLN, Ames, Iowa. (Age 22) 1939 B.S. in Civ. Eng., Iowa State Coll.; at present Asst. Research Engr., Iowa Eng. Experiment Station.

DOWNEY, PAUL WILLIAM, Washington, D.C. (Age 26) (Claims RC 3.2 D 1.0) Sept. 1930 to date with District of Columbia Govt. as Physical Tester, acting as Testing Laboratory Technician, Office Engr., and (since March 1936) Asst. Engr. of Materials.